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FIG. 1.—ZION CANYON, ZION FORK OF VIRGIN RIVER.

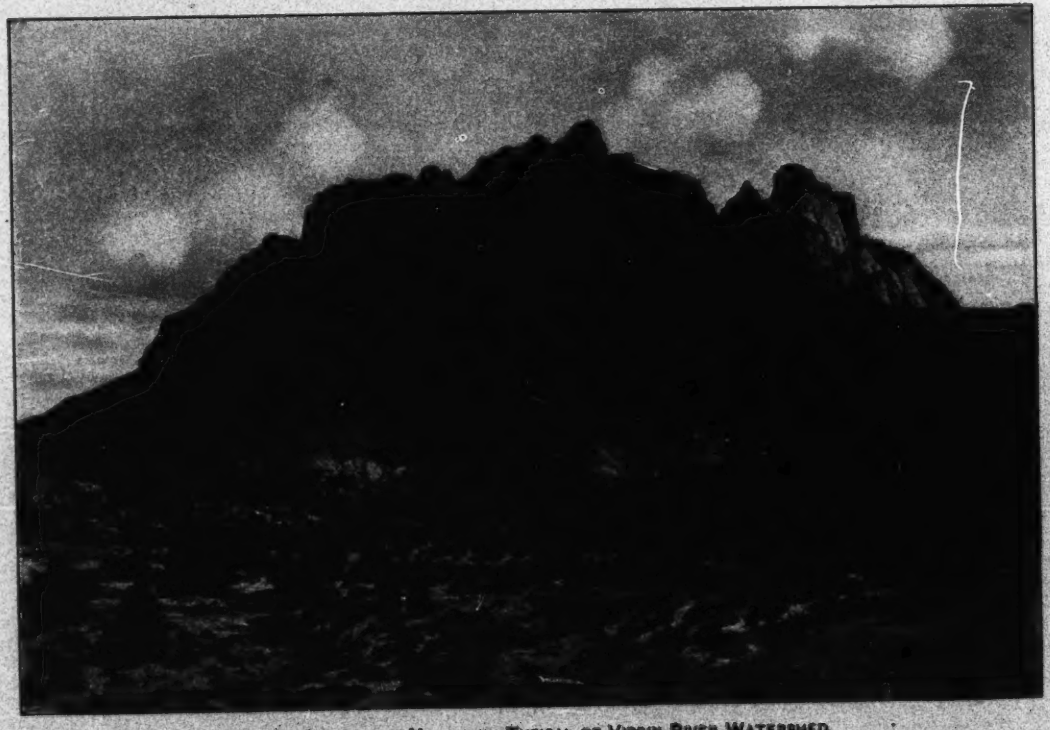

FIG. 2.—STEAMBOAT MOUNTAIN, TYPICAL OF VIRGIN RIVER WATERSHED.

58TH CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { DOCUMENT No. 720.

545

U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS—BULLETIN NO. 124.

A. C. TRUE, Director.

# REPORT

OF

# IRRIGATION INVESTIGATIONS IN UTAH,

UNDER THE DIRECTION OF

ELWOOD MEAD,
CHIEF OF IRRIGATION INVESTIGATIONS,

ASSISTED BY

R. P. TEELE, A. P. STOVER, A. F. DOREMUS, J. D. STANNARD,
FRANK ADAMS, AND G. L. SWENDSEN.

WASHINGTON:
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1904.

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# LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
*Washington, D. C., January 17, 1903.*

SIR: I have the honor to transmit herewith and recommend for publication as a bulletin of this Office a report on irrigation conditions in Utah, made under the supervision of Elwood Mead, chief of the irrigation investigations of this Office. The report deals with important questions and presents facts of vital interest to the people of Utah and students of irrigation elsewhere. The farmers of Utah have originated certain methods of cooperative control of quasi-public utilities which seem to be worthy of a wider field of usefulness. The problem now is to provide the measure of public control which is necessary to safeguard and give the best results from this cooperation. It is believed that the reports submitted herewith will supply much data which will be of value in settling controversies over rights to water. The report is accompanied by 19 full-page plates which are considered necessary to the proper illustration of the reports.

Respectfully,

A. C. TRUE,
*Director.*

Hon. JAMES WILSON,
*Secretary of Agriculture.*

# LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
*Washington, D. C., January 15, 1903.*

SIR: I have the honor to submit herewith a report on the laws and customs under which water is diverted, controlled, and used in irrigation in Utah. Following the plan adopted in a similar investigation in California, five typical drainage basins were selected, and the conditions in each of these made the subject of special study. The streams selected were the Weber and Logan rivers in northern Utah, the Jordan River and its tributaries in central Utah, and the Virgin and Sevier rivers in the southern part of the State. Three of these reports were prepared by residents of the State, two of whom have had official as well as personal opportunities for becoming fully informed regarding existing conditions, one being State engineer and the other professor of irrigation engineering in the State agricultural college. The other four reports were prepared by agents of this investigation who have carried on similar studies in other States and were enabled thereby to compare the institutions of Utah with those of neighboring Commonwealths.

The purpose of this report is to present the irrigation situation of Utah in a concrete form; to show the character, extent, and stability of the rights to water thus far established; the problems which confront water users, and the complications which need to be removed in order that each farmer may be protected in his just share of the water supply and litigation and controversy over the division of streams averted. It is hoped that it will be of service to Utah in extending the reclaimed area and in giving greater value to irrigated land and water rights.

Wherever the significance of the facts gathered has been discussed, especial care has been exercised that it should be done with entire candor and fairness. No attempt has been made to outline a system of laws or give details of needed legislation. The gathering of the facts showing the operation of existing laws has been undertaken by this Office because it can best be performed by some agency not affected by local or selfish considerations. But the responsibility for the enactment of laws rests with the people of the State, and it is only expected that this report will be effective through the lesson taught by the facts presented.

The influence of the Mormon Church in shaping and promoting agricultural development has given to the irrigation system of Utah many interesting and unique features. In the early years of settlement there was no provision for acquiring legal titles to either land or water, and without the supervision of the church authorities, acting as arbiters and advisers, there would have been no rule except that of force.

With few exceptions, controversies were settled as they arose, without friction, so that irrigated Utah was for many years a land of homes almost free from incumbrance and of industrial institutions well suited to the arid West. In recent years, however, the lack of clearly defined and legally established titles to water has had many disadvantages and is at present a positive menace to the future of the State. The growing value of water for power purposes, the greater demands of cities and towns for domestic supplies, the lack of unity in religious faith, make it no longer possible to secure a settlement of water-right questions by voluntary agreements or by arbitration under the direction of the authorities of the Mormon Church. The urgent need of Utah is some simple, final method of establishing titles to water and the protection of those titles in times of scarcity. The enactment of laws to insure this has been delayed because of a fear among the farmers of the State that any system of public control will involve a sacrifice of some of their rights, but an analysis of existing conditions does not show this to be well founded. No system of public control can go farther in defining or limiting rights than the courts have gone in the litigation of the past ten years. The question which the irrigators of Utah must decide is whether the present system of adjudicating rights can be improved upon and how these rights are to be protected when established.

The situation on the Jordan River, where rights to the main stream and the streams which flow into Utah Lake have been established independently of each other, is worthy of careful consideration. One lesson seems to be clear, the establishment of rights to water, whether by the courts or by a specially constituted tribunal, should embrace the entire drainage basin of a stream. Legislation which will make this mandatory would do much to simplify the existing water-right situation.

The methods of dividing water from ditches, practiced by the irrigators of Utah, may well be studied by the people of other arid States, while the people of Utah can study with profit the administrative laws of neighboring States.

Respectfully,

ELWOOD MEAD,
*Chief of Irrigation Investigations.*

Dr. A. C. TRUE, *Director.*

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18189—No. 124—03——2

# IRRIGATION INVESTIGATIONS IN UTAH.

## GENERAL DISCUSSION OF IRRIGATION IN UTAH.

By R. P. Teele,
*Assistant in Irrigation Investigations.*

All studies of irrigation lead to one conclusion—that some public control of the water supply is necessary to the best use of the resources of an arid country. In the very nature of things conflicts will arise, and when they do arise some power beyond the conflicting parties must come in to define their respective rights. The most important question in irrigation in this country is, Who shall be the arbiter when such conflicts over water arise? Or, is it not possible to create a system of water administration which will anticipate such conflicts and render them impossible? This report is a study of these questions in the State of Utah.[a] This State is not a new field giving free opportunity for the creation of an ideal, but one in which rights have become vested, customs have grown up, and legal principles have become established. It is, therefore, necessary to study the history of the State in its dealings with water, both within and without the law, to see wherein the laws and customs have produced good results and wherein they have failed; to see what principles have become established with which new laws must conform or be declared void. Such a study has two objects. The first is to help the people of Utah in the establishment of an irrigation system which will bring about the largest use of their water supply; the second is to present to other States having like conditions the lessons of Utah's experience.

Up to the last few years the people of Utah have been very largely of one faith and controversies over water have been settled through church influences. This led to delay in the legal definition of rights to water. Increased demands for water and the coming in of others than members of the dominant church have in the last few years brought to the people of Utah the necessity of having some other foundation for rights than agreements between themselves. There has come, therefore, from within the State a strong demand for such information as is given in the following reports.

With respect to the development of irrigation laws and customs, the arid part of the United States may be divided into three sections. The first, in time of settle-

[a] The reports contained in this volume were written during the years 1901 and 1902, before the passage of the law of 1903, discussed in the succeeding pages. They therefore make no mention of that law. Publication of the report was delayed by various causes, and it was thought best to bring this general discussion up to date by giving the subetance of this new law.

ment, comprises the Southern Territories which were settled by the Spaniards, the second is Utah, and the third includes the other arid States. The developments in each of these sections have been, until recently, largely independent of both the others. Utah, therefore, is especially interesting in having a history peculiar to itself and in being uninfluenced by the developments in the other States. Left to themselves, the people of Utah have developed many customs which can be adopted by the other States with profit.

## PHYSICAL CHARACTERISTICS.

Utah lies on the eastern side of the great basin between the Rocky Mountains on the east and the Sierra Nevada on the west. The greater part of the State is rough and mountainous, only the northwest corner, in which lie the Great Salt Lake and the Great Salt Lake Desert; and the Sevier Desert, having any large areas of level land. Throughout the rest of the State lands which can be farmed lie along the streams where their valleys widen out, leaving small areas of level land. The greater part of the irrigated lands lie along the borders of the Great Salt Lake and Utah Lake, between lakes and mountains which surround their valleys; but small areas along all the streams of the State, which together aggregate quite an acreage, have been reclaimed. Hon. A. F. Doremus, State engineer of Utah, estimates the total area of irrigated land in the State at 500,000 acres, or less than 1 per cent of the total area of the State.

The elevation of these irrigated lands above sea level varies from a little more than 4,200 feet around Great Salt Lake to about 7,000 feet in some of the higher valleys along the streams.

The climate is typical of the Rocky Mountain region. The mean monthly precipitation for the State is given in the following table:

*Mean monthly precipitation for State of Utah.*

| | Inches. |
|---|---|
| January | 1.03 |
| February | 1.19 |
| March | 1.44 |
| April | 1.01 |
| May | 1.13 |
| June | .40 |
| July | .62 |
| August | .76 |
| September | .71 |
| October | .93 |
| November | .83 |
| December | .94 |
| Annual | 10.99 |

The rainfall for the five months of the growing period, May to September inclusive, is 3.62 inches, or approximately one-third of the total for the year, so that if it were all in the form of rain, about two-thirds of the annual precipitation would not be available for crops, unless it was stored. But a large part of it is in the form of snow, much of which falls on the high mountains, and serves to maintain the flow

of the streams throughout the summer. It is to this snowfall in the mountains that the farmers of Utah look for their water supply, rather than to the rainfall during the growing season.

The temperature ranges from maxima of about 100 degrees in the summer to minima of a few degrees below zero in the winter, the summer having the hot days and cool nights characteristic of the Rocky Mountain region.

During the year 1902 Salt Lake City had 169 clear days, 87 partly cloudy days, and 109 cloudy days, showing a large percentage of sunshine. In fact, the feature of the climate which is most noticed by visitors from the East is the clear, dry air and the almost continuous sunshine.

## CROPS.

The greatest crop of Utah is alfalfa. It is raised in the highest mountain valleys and around the lakes, in the temperate climate of the north end of the State, and in the semitropical valley of Virgin River in the south. In the higher valleys, aside from alfalfa, the principal crops are grains and hardy vegetables, the climate being too severe for fruits. In the valleys of Great Salt Lake and Utah Lake sugar beets are extensively raised, and in the neighborhood of Ogden large areas of tomatoes and other vegetables are raised and packed for shipping. Deciduous fruits are also extensively raised. In the valley of Virgin River, in the extreme southern end of the State, the semitropical crops, cotton and cane, have been raised. But throughout the whole State alfalfa and the grains are the principal crops raised. The 99 per cent of the area of the State which is not irrigated is largely used for grazing, the alfalfa raised in the valleys being used to feed the sheep which graze on the mountainous lands. Mining has also had a large development. It was the intention of the Mormon pioneers to make their new home self-supporting, and Utah comes as near being so as any State in the Union. The State produces all that her people need to eat and wear. The shoe factories at Salt Lake City, the woolen mills at Provo, and the cotton mills at St. George all help to make the people of Utah independent of the rest of the country. The sheep raisers, the miners, and the people of the cities provide a market for everything the farmer raises, making him independent of the outside world, even in disposing of his crops.

## IRRIGATION LEGISLATION AND WATER CONTROL.

The announced desire of the Mormon pioneers who settled in Utah in 1847 was to get to a place so far away from other settlements that they might follow the teachings of their religion without interference from those not of their faith. It certainly seemed that they had chosen wisely in selecting the valley of Great Salt Lake. It was a thousand miles from the nearest settlements on the east and almost as far from the California settlements on the west. What were considered almost impassible deserts surrounded it on all sides. The only white men who had visited the valleys were trappers and explorers. It was nominally under the sovereignty of Mexico, but in reality there was no established form of government. At the close of the Mexican war sovereignty passed to the United States, but still no government

was established. In addition to being without established government, the region to which they had come required a kind of agriculture new to what was then the United States. Irrigation engineering and irrigated agriculture were alike unknown to them. More than all this, there was no means of acquiring title to land in what was later the Territory of Utah, and no system of water rights had been worked out in this country. We find the Mormon settlers in the valley of Great Salt Lake pioneers indeed—settlers in a new country without established government and requiring a new system of engineering and of agriculture. The absence of laws or established customs left them free to develop their institutions without the necessity of conforming to existing rules, while the authority of the church which dealt with both religious and civil affairs prevented those conflicts over titles to both land and water which would otherwise have arisen.

The enthusiasm of converts to a new faith, opposition in Ohio, Missouri, and Illinois, and the long journey across the desert and among hostile Indians brought the Mormon pioneers to the Jordan Valley in 1847, welded together into a community of interest which led to cooperation along all lines and, after a government was established, to a high degree of paternalism. Together they built their stockades for protection from Indians, built their ditches to water the land, and planted and harvested their crops. They found, however, that government was necessary, even in a community united as they were. Since Congress had failed to provide a government, Brigham Young and his followers organized in 1849 the State of Deseret for the government of "that portion of the territory of the United States lying west of the Rocky Mountains and in the great interior basin of Upper California * * * until the Congress of the United States shall otherwise provide for the government of the territory hereinafter described by admitting us into the Union."[a]

The development of laws and customs in this virgin field is peculiarly interesting and instructive. The constitution of the State of Deseret made no mention of irrigation, but its legislature disposed of the natural resources of its territory, including water, by legislative grants. This State was succeeded in 1851 by the Territorial government created by Congress. The act of Congress creating the Territory was also silent on the subject of irrigation, but the legislature of the Territory, like that of the State of Deseret, assumed the right to dispose of the timber and water privileges by grant. It also passed a law delegating this power to the county courts of the several counties of the Territory. The county court was composed of the probate judge and the county selectmen and had general supervision of county business. So far as shown by the reports, the court of Salt Lake County was the only one in the Territory which assumed the duties relating to water conferred by this law. That court granted rights to the streams of the county, appointed water masters to enforce its decrees, refused petitions for rights when streams had been exhausted, settled controversies over the use of water, and finally executed deeds to the waters of Jordan River. In the other counties streams seem to have been diverted without public restrictions.

A new irrigation law was passed in 1880. The necessity for this law was the failure to enforce the earlier law. Along many streams more land had been brought

[a] Constitution of the State of Deseret, Revised Laws of Utah, 1855, pp. 44, 45.

under ditch than the streams could water, and it was necessary to provide some means of settling the resulting conflicts. The law made the county selectmen ex-officio water commissioners, with power to measure streams, hear all claims to water, settle all disputes over the use of water, superintend either in person or by agents the distribution of water among those entitled to it, and to issue certificates of their findings regarding water rights. These certificates were to be filed for record with the county recorders. Provision was made for intercounty boards where streams were in more than one county, the certificates issued by these boards to be filed in each of the counties affected. The object of this law was to provide records of all existing rights to water and thus do away with causes of conflict and give notice to intending appropriators from streams of the extent of existing rights, and also to provide a convenient and inexpensive means of settling controversies which might arise in the future. This law, like its predecessor, was enforced in only a few counties, and the certificates issued in those counties are generally considered worthless, as the law was held to be void in that it granted judicial power to a body not named in the section of the organic law which created the courts of the Territory. The matter never came to the supreme court of the Territory, but the law is commonly acknowledged to be void. Although this law had little effect, it shows a fundamental change in principle from the original law. Under that law water was public property, to be disposed of by grant. Under the new law rights to water were acquired without supervision, the public authorities being called on only in case of controversy. That is, the Territory was no longer considered the owner of water supplies, but merely as having police power. Neither law was enforced; hence this change in principle was unimportant except in its effect on future attempts at legislation.

One principle of this law has lived, however, and been reenacted and its principle extended in court decisions. This is the definition of primary and secondary rights. All rights to the use of a stream acquired up to the time that the sum of the rights is equal to the ordinary low-water flow of the stream are primary rights, and seven years undisturbed use gives a primary right. Those acquiring rights to water after the low-water flow is exhausted, or who use water during high water, have secondary rights. In times of scarcity holders of secondary rights receive no water, and whatever water a stream furnishes is divided among the holders of primary rights pro rata according to their respective rights, and these rights are sometimes based on the area irrigated and sometimes on a ratio fixed by the court which defined the rights to that stream. There is no general rule. The law carries the classification no further than the two classes, but some of the court decisions cited in the reports carry the same principle further and divide the rights to a single stream into a large number of classes. In such cases the first class first receives what water it needs, if there is enough water the second class takes what it needs, and so on until a class is reached for which there is not enough water. All classes below this get no water, and what water is not needed by higher classes is divided pro rata among the holders of rights in the class in which there is a shortage. This division of rights into classes is peculiar to Utah and is a wise compromise between the absolute "priority" theory enforced in some States, under which the first comer takes the full volume of water to which he is entitled, regardless of the needs of his neighbors, and the utter disregard of priority, advocated by some, under which the lands of the early settler can be robbed

of their value by compelling him to divide his water supply with an ever-increasing number of irrigators.

No further irrigation legislation was enacted until 1897. Utah became a State in 1896, and an attempt was made in the constitutional convention to place in the constitution the basis for a comprehensive code of water laws. The friends of this movement considered it necessary to adopt a declaration that water was the property of the State, and this created a fear among the people that the proposed change meant a confiscation of their property, and they preferred to leave matters as they were, claiming that the State had no rights in the water. The constitution adopted had therefore but one sentence on the subject of irrigation, although irrigation is the foundation of most of the industries of the State. It declared that "all existing rights to the use of any of the waters of this State for any useful or beneficial purpose are hereby recognized and confirmed." (Art. XVII.)

A more successful campaign was made in 1897. A law was passed creating the office of State engineer. The chief duties of the engineer were to inspect dams and "keep a full and complete record of all measurements of streams, and all other valuable information in relation to irrigation matters that may come to his knowledge." The appropriation for the office was so small as to render the engineer appointed almost helpless, but the office has been filled since that date, and the engineer has done more than could be expected with the small means at his command.

In the same year a law was passed accepting the conditions of the "Carey Act," but nothing has ever been accomplished under this law.

Another irrigation law was passed in 1897, the purpose of which was to define and record all existing rights to water and provide a system for acquiring such rights in the future, thus placing the whole matter of water rights on a definite basis. The law provided that rights to the use of water might be acquired by appropriation and prescribed rules to be followed by the appropriator. He was required to post a notice at the place of intended diversion and one in the nearest post-office, stating the volume claimed, the purpose for which it was claimed, the place of intended use, and, if for irrigation, the area to be irrigated, the means of diversion, the date of appropriation, and the name of the appropriator. He was also required to file for record in the county where the diversion was to be made a notice stating the facts contained in the posted notice and also the name of the stream and a description of the point of diversion. The appropriator was required to begin work within forty days from the time of posting the notice and prosecute the work with reasonable diligence to completion. The excess of water claimed above the capacity of the ditch was subject to appropriation by others. This law was similar to those in force in other States, and was a failure here, as elsewhere. Its purpose was to provide a record of water rights; but there was no limit to the claims which might be filed and nothing on the records to show whether any work was ever done under the filings. The law provided that when the appropriator complied with its provisions his right should date back to the time of posting the notice. The only possible effects of the law were along the line of this provision and as a menace to development. Notices filed by those who did not follow up their plans tended to keep others from building works for fear of conflicts with those who posted the notices. The Jordan River report gives an instance in which parties wishing to build works paid a

considerable sum to other parties who had filed a notice, but had done little else. To make the record of water rights complete the law provided that persons who had already acquired rights to water might file notices similar to those required of new appropriators, but their failure to do so should not work any injury to their rights. Very few parties have taken advantage of this law, and it is therefore practically useless. The law contained the old definition of primary and secondary rights and a large number of miscellaneous provisions.

In 1901 another attempt to secure a satisfactory system of water laws was made, but was only partially successful. The law as proposed provided for the adjudication and recording of all existing rights to water and the control by a State board of the acquirement of rights in the future, thus making it possible for a party wishing to secure water rights to find out whether there was unappropriated water in the stream which he wished to use and protecting the holders of existing rights against unauthorized appropriation of their water supply. This part of the bill failed to pass. Based on this part of the bill was a provision for the appointment of water commissioners to distribute the water of the State to those entitled to its use. This section passed. It provided that the board of commissioners of each county might divide its county into water districts and appoint for each district a water commissioner, who should divide the streams in his district among water users "according to the prior rights of each." Since on many streams the rights are not defined, these commissioners had no basis on which to divide the water. The appointment of water commissioners was optional with the county commissioners, and the law has been complied with in only a part of the counties; but the commissioners have done a good deal toward a peaceable division of the water supply during the two years that they have been in office. Where rights have been defined by the courts, the decrees are followed by the commissioners; where they have not been defined, the commissioners follow their own judgment, based on common understandings, the needs of crops, and any other information they may have. The people of Utah, as a rule, love peace and are willing to make some sacrifice of what they consider their rights in order that they may live in peace with their neighbors. This spirit of compromise is what has made it possible for the water commissioners to divide the water of many of the streams of the State.

As pointed out above, water rights for the most part have grown up outside the laws which have been enacted. The State of Deseret and the Territory of Utah apparently began with the idea that rights could be acquired only by grant; but the plentiful supply of water in the early days led to slackness in this matter, and parties were allowed to divert and use water without restriction. Most of the rights to water have been acquired under this implied permission and are naturally undefined in any way. The law passed in 1880, and referred to above, provided for the definition of all these rights, but that law was only partially enforced and has been considered void, leaving rights still undefined. No law providing for their definition was passed until 1903, and, as a consequence, such rights as have been defined in any way have received such definition from the courts, with very few exceptions. The law of 1880 also provided for the distribution of the water by the agents of the county selectmen acting as water commissioners, but this provision, like the rest of the law, has never been enforced. This matter, like the defining of rights, had been left to the courts

until the passage of the law of 1901, which provided for the appointment of commissioners.

In the absence of public control outside the courts the people of Utah have very generally settled their differences by arbitration, usually with church officials as arbiters. The decisions of the arbiters have taken many forms. The settlement of water rights on Jordan River took the form of deeds from the county court to the canal companies. The settlement of the controversies over the use of Utah Lake as a reservoir took the form of a contract between the parties owning land bordering the lake and the Salt Lake County parties who wished to store water in the lake. The use of American Fork River was controlled by a decree of a church court, while the division of Provo River has been in accordance with agreements between the parties claiming rights to that stream. During the past few years there has been a marked tendency to take these matters to the courts for the sake of giving the force of judicial decrees to the agreements reached. Not all water-right suits are of this friendly nature, but many of them are, and most of the decrees are based on agreements of the parties or follow closely agreements which have been in force. Thus the Jordan River decree, although it ignores the deeds given to the canal companies by the county court, follows the divisions made in those deeds, which had been followed for twenty years. The Provo River decree is almost an exact copy of an agreement drawn up by the parties at interest. The Spanish Fork decree bears evidence of the same origin, and the Virgin River report says that a movement is on foot, under the direction of the church officials, to have the rights to that stream taken up and defined by the United States court.

The progress of the settlement of rights on the streams reported on is given below: The rights of existing canals on the Jordan, Provo, American Fork, and Spanish Fork rivers have been defined by the courts; most rights to Weber River have never been defined, either by agreements or decrees; the same is true of the Virgin River and its tributaries; many suits relating to rights to Sevier River have been decided, but they are conflicting and no general decree for the stream has been rendered; the rights of the Logan River canals have never been taken up, as there is enough water for all. Even on the streams where decrees have been rendered rights can not be considered settled. Since the defining of the rights to Jordan River a number of new claims have been filed and several transfers of rights have been attempted and resisted. These matters can be settled only by new suits, and when they are settled similar questions may arise at any time. The Spanish Fork decree makes no mention of one of the oldest canals on that river, and after dividing the whole stream among the canals named states that they are the only ones taking water from the river. All admit that the canal omitted has rights, and the decree can not be considered as final under the circumstances. The Provo River is divided into two sections, which are treated as entirely independent, although diversions in the upper section must have an effect on the lower section. This relation must some day be recognized, when the present decrees will have to be set aside.

To sum up the status of water control in Utah at the time of the passage of the law of 1903, referred to below: The county commissioners of many of the counties had appointed water commissioners. On some streams these commissioners had little but their own judgment to guide them; on others they had court decrees to

govern their actions. While all questions between water users must eventually be settled by the courts, when they arise they have been settled by the water commissioners, pending decisions by the courts. The acquirement of rights by persons building new works was without control of any kind. The law required the posting and filing of notices, but there was no supervision of these acts or inspection to see that the notices and works agreed. The person wishing to divert water had only to post and file his notice, build his works, and then take water, if he could get it, until stopped by the water commissioner or by his neighbors. Discussing this situation, the State engineer of Utah, in his report for the years 1901 and 1902,[a] says:

> The definition of existing rights appears to be of first importance. This is not only necessary to pacify present contention, but to prevent future conflicts and encourage further progress. There can be no safe basis for future work before existing rights are known and made of public record. All future work and rights on existing systems must be based on the remnant of unappropriated water of these systems. The extent of this remnant can not be ascertained before the measure of appropriated water is known, and as the sum of the existing rights is the measure of the water appropriated, it is evident that the extent of the remnant can not be known before the existing rights shall have first been determined.
>
> To defer the definition of these rights is not only to prolong the present general conflict, but to extend the cause of contention by permitting the number of uncertain rights to increase. In the meantime all plans for betterment must of necessity be based on no better foundation than that of uncertain rights, and be liable to the same disturbance, litigation, and loss that involve all present undefined rights.
>
> It is true that the fear of future trouble from this source has not prevented some projects from development, but this was the result of a necessity which compelled action for self-preservation, in spite of these well-known difficulties. The course of all these would be made infinitely easier if relieved of the incumbrance which indefinite right imposes.

## THE IRRIGATION LAW OF 1903.

The principal weaknesses of this system were that rights were not defined until they came into controversy. Their definition depended on testimony submitted by the interested parties or on agreements between those parties, and not on physical facts which should be determined by measurements made by disinterested parties, and these settlements when made were not final, since new diversions were entirely without control. The law of 1903 was drawn for the purpose of remedying these very weaknesses—that is, for the purpose of defining all existing rights, and of providing for the control of the acquirement of rights in the future, thus making all rights a matter of record, giving those charged with the distribution of water a definite basis for its division, and giving notice of the extent of existing rights to those desiring to obtain rights to divert water. The provision for the definition of existing rights is as follows:

The State engineer is to survey and map all the streams of the State and measure their discharge, beginning with the streams most used for irrigation. When he has finished the survey of any stream he is to report this fact to the district court of the county where the stream is situated; and if the stream extends to more than one county, he may report to the court of the county which is most convenient for all those using water from the stream. He is to file with the report of the survey the

[a] Third biennial report of the State engineer to the governor of Utah, 1901 and 1902, Salt Lake City, 1903, p. 15.

names and addresses of all the parties using water from the stream and any other facts which he deems necessary. Within thirty days from the time of the filing of this statement the clerk of the court in which it is filed is to give notice that all parties claiming rights to use water from the stream must within six months of the date of the first publication of the notice file statements setting forth their claims. This notice is to be published for three months and also sent by registered mail to each party named in the report of the State engineer. The statement filed is to contain the following:

The name and post-office address of the person, corporation, or association making the claim; the nature of the use on which the claim of appropriation is based; the flow per second of water used and the time during which it has been used each year; the name of the stream or other source from which the water is diverted; the place on such stream or source where the water is diverted and the nature of the diverting works; the date when the first work for diverting the water was begun and the nature of such work; the dimensions, grade, shape, and nature of the diverting channel, as originally constructed; the date when the original diverting channel was completed; the date when the water was first used, the flow per second, and the time during which the water was used the first year; the date and nature of each subsequent change made in the original diverting channel; the flow per second of the water used and the time it was used each year between each of the changes so made, and the dimensions, grade, shape, and nature of the present diverting channel; the place where and the manner in which the water was first used; the nature of each subsequent change in the place or manner of use, and the place and manner of present use, and such other facts as will clearly define the extent and nature of the appropriation claimed.

If the water claimed to have been appropriated is used for irrigation, the statement shall show, in addition to the above-required facts, the area of land irrigated the first year and each subsequent year; the total area at present irrigated and its location in the section, township, and range wherein it is situated; the character of the soil and the kind of crops raised during the first year of use and the first year after each subsequent change of channel and during the last year in which the water was applied.

If the water claimed to have been appropriated is used for developing power, the statement shall show, in addition to the above-required facts, the number, size, and kind of water wheels employed, the head under which each wheel is operated, the extent of the power produced, and the purposes for which and the places where it is used and the point where the water is returned to the natural stream.

If the water claimed to have been appropriated is used for mining, the statement shall show, in addition to the above-required facts, the name of the mine and the mining district in which it is situated, the nature of the material mined, and the place where the water is returned to the natural channel of the stream.

Any party failing to file a statement as above is forever barred from asserting any claim of right to use water from the stream in question, unless he can prove to the satisfaction of the court that he had no actual notice of the action to determine his rights.

Within sixty days after the expiration of the six months allowed for these filings the State engineer is to tabulate the facts contained in these statements and file a copy of this tabulation with the clerk of the court.

At the expiration of the time allowed for filing the statements the court may appoint referees to take testimony and prepare findings and the form of a decree, or may hear the case without reference. The decree is to define the rights of the several claimants, and among other things shall set forth:

The name and post-office address of the person, corporation, or association entitled to the use of the water; the flow per second of water entitled to be used; the purpose for which the water is to be used;

the time during which the water is to be used each year; the name of the stream or other source from which the water is diverted; the place on the stream or other source where the water is diverted; the priority number of the right; the date of the right, and such other matters as will fully and completely define the right of said person, corporation, or association to the use of the water.

Appeal may be taken to the supreme court of the State within six months; but if no appeal is taken within six months, or if the case is appealed within thirty days after the final decree is entered, the clerk of the court must issue to each party having been awarded the use of water by the decree a certificate setting forth the substance of the decree. One copy of this certificate is to be filed with the county recorder and one copy with the State engineer.

The law of 1880 was an attempt to accomplish the results aimed at in the present law, but it failed by granting the powers given to the court by the present law to the county selectmen and also leaving the proceedings for the definition of rights to be initiated by those claiming rights. The new law avoids these points by leaving the matter to the courts and providing for the bringing of action by the State engineer, thus making it possible to bring all the rights in the State into court for definition. This will take years, but it can be brought about under the new law, while it could not under the old. The new law makes no change in the jurisdiction of the courts, except to give a single court jurisdiction over a whole river system, but it does provide that in defining the rights to water from a stream the court shall be supplied by the State engineer with full information as to the water supply and the areas irrigated, instead of depending for these facts, without which a decree must be more or less guesswork, on the testimony of interested parties who are not always competent to give such testimony. The court is left free to define rights as it will, but the law provides that it shall have the data necessary for an intelligent decision.

One of the greatest weaknesses of the old system was that rights were never settled, since anyone was free to go to a stream and take water until stopped by appeal to the courts. This has been remedied by placing the water of the State under the control of the State engineer, and providing that rights shall be acquired by grant from the engineer. That is, no one can now go to a stream and divert water at will, but anyone wishing to acquire a right must make application to the State engineer and receive a permit from him before works can be commenced or water taken. In other words, the new law returns to the principle of the first law, and makes the State owner of the water instead of being possessed of police power only. To guard against arbitrary action by the engineer, the law provides for appeal to the courts by anyone not satisfied with his ruling on an application. The engineer is to keep a record of all applications and his action on them, and when works are completed in accordance with the permits issued certificates of rights similar to those issued by the courts are to be given by the engineer and filed with those issued by the courts. There will then be in each county a record of all rights to use the streams of the county, and in the office of the State engineer records for all the streams in the State. When rights have once been defined by the courts the holders of rights will be relieved of the necessity of defending themselves against future appropriators, since the engineer is required to reject any application "where there is no unappropriated water in the proposed source of supply, or where the proposed use will conflict with existing rights or threatens to prove detrimental to the public interests."

Under the laws of Utah water rights are not attached to the land, but may be transferred separately from any land. Under the new law such transfers must be

by deed, and the deeds must be recorded, or the transfers are void as against any subsequent purchaser in good faith and for a valuable consideration who records his own deed. The record of water rights will thus be complete—the court will define existing rights, all transfers will be of record, and certificates of all new rights will be issued and recorded.

The law also provides for the distribution of the water of the State among those having rights to its use by the agents of the State engineer, but provides that the present water commissioners shall continue to act until superseded by the officers provided for in the new law. The engineer is to divide the State into water divisions and subdivide these into districts from time to time as necessity arises. There is to be a superintendent for each division, who is to be appointed by the engineer with the consent of the governor, and the superintendent has power, with the consent of the engineer, to appoint a supervisor for each district in his division, who shall be a resident of the county and district in which he is to serve, and who shall be confirmed by the board of county commissioners of the county. The supervisors have immediate charge of the division of the water of the streams in their respective districts, and the superintendents have general charge of the supervisors in their divisions, and they in turn are subject to orders from the State engineer.

## LIMITATION OF WATER RIGHTS.

It has been stated that some features of Utah's irrigation system could with profit be studied by the people of the other arid States. Chief among these is its system of defining the extent of water rights. Most of the rights to Utah's streams were initiated without public supervision and hence were not defined as to extent, and when they came up for definition the question naturally arose as to what should determine the extent of rights. The general principle announced in the law of 1880 was that all parties should have the right to continue to use water as they had done in the past. In addition, the law provided that these rights should be measured as follows:

> A right to the use of water may be measured by fractional parts of the whole source of supply, or by fractional parts with a limitation as to periods of time when used, or intended to be used; or it may be measured by cubic inches, with a limitation specifying the depth, width, and declination of the water at point of measurement, and, if necessary, with further limitations as to periods of time when used, or intended to be used.

The other arid States have followed the general principle announced by this law, but not the section of the law quoted above. The practice in those States is to define a right as to volume alone, giving the holder of the right the privilege of using that volume of water at any or all times. Under such a practice, holders of early rights who have used water for only a short period each year may later enlarge their use to the great injury of those who have come later but found plenty of unused water when they came. Under the Utah law the rights of such parties are limited as to time as well as quantity, and later comers are safe from an enlarged use under the older right. Good examples of the working of this system in Utah are given in the Provo River report (page 133), the Spanish Fork River report (page 165), and the American Fork River report (page 138). The law of 1903 changes the old system in this respect: It provides for the defining of all rights in terms of cubic feet per second rather than in fractional parts of the whole supply, but retains the provision for

limiting them as to time. The granting of rights to continuous flow has been the source of more injustice and controversy in the arid States than any other one cause, and Utah has avoided all this by her provision for limiting rights as to time.

## THE ORGANIZATION OF CANAL COMPANIES.

The early irrigation ditches were small and were built by the cooperation of a few settlers who were banded together by no formal organizations. During the first few years of the Territorial existence the legislature chartered a few companies. These were to be stock companies, each share of stock entitling its holder to one vote in the management of the company.

In 1865 an act was passed providing for the incorporation of irrigation companies. This has been known as the irrigation-district law. Under it the people of any county or part thereof who desired an increased water supply might petition the county court for the organization of an irrigation district. Elections of officers and the vote on the question of the organization of the district and the rate of taxation were to be under the direction of the county court, and annual reports were to be made to the same body. The lands of the district were to be taxed to build and maintain necessary irrigation works. Under this law a large number of districts were organized, but they were generally short lived. The law was amended from time to time in an effort to make it of use, but it was repealed in 1897, having accomplished almost no results. The distinctive feature of the irrigation-district laws of other States—the power to issue bonds—was not included in this law. The people had only the power to tax themselves, and this they could do in effect without the law.

The typical form of canal company in Utah is the cooperative stock company. The capital stock of such a company is issued in payment for work or for money, and is usually owned by the owners of the lands to be irrigated by the canal, although outsiders sometimes subscribe for stock. The Virgin River report gives an instance of the Mormon Church subscribing for stock for the purpose of helping the people of that valley to complete an expensive canal. The stockholders elect a board of directors and officers, who have immediate control of the canal and who transact the business of the company. All expenses of management and operation of the canal are met by annual assessments on the stock. These assessments, like the original price of the stock, are largely paid in work. The water furnished by the canal is divided among the stockholders in proportion to the stock held by each, and no water is furnished to others than stockholders, but stock may be sold or rented and the water delivered to the new party. It is thus possible for stock to be owned by those not owning land under the canal and for the stock to accumulate in a few hands, but so far neither of these tendencies has manifested itself.

A modification of this plan is known as the incorporation of a stream. Under this plan all parties who have acquired rights to a stream deed their rights to the company which is to control the stream. In return for this they receive stock in the company, usually in proportion to the area of land which each was irrigating with water from the stream. Members of such a company express their interest in the company as so many "acres of water right." The companies are managed like the other cooperative companies.

A few corporations for the construction of canals and the sale of water to farmers have been organized, but have proven financial failures.

## DISTRIBUTION OF WATER UNDER CANALS.

The distribution of water from the streams to canals has been touched upon in the preceding pages. Most of the canals whose rights have been defined have rights to fractional parts of the supply in the stream which they divert. Likewise the individual water users have rights to fractional parts of the supply furnished by their canal. Under the canals there is this difference, however: Instead of each user getting a stream proportioned to his interest in his canal he gets a larger stream, but gets it for a period of time proportioned to his interest in the canal. The usual custom is for the farmers taking water from a common source to decide how often each shall receive the water—say once in eight and one-half days—then determine how long this will allow water to each share of stock or acre of ground, as the case may be, and prepare a schedule accordingly. Under a small canal a farmer may receive the full flow of the canal one hour per acre once in eight and one-half days.

## RESULTS OF IRRIGATION.

While this investigation deals chiefly with the irrigation laws and institutions of Utah, the reports contain a large amount of information on the quantity of water used and crop returns. This information is summarized below:

### DUTY OF WATER.

The table following contains the statements on the duty of water where the measurements covered a whole season. The statements covering the large canals from the Jordan River are not included in the summary because of the uncertainty as to the area irrigated and the shortness of the water supply. The Weber River statements are omitted because they cover only a part of a season:

*Duty of water.*

| Name of canal. | Area served by 1 cubic foot per second. | Depth on land. |
|---|---|---|
| | *Acres.* | *Feet.* |
| Jordan River: | | |
| Mousley Ditch | 36.90 | 6.60 |
| Beckstead Ditch | 48.70 | 4.97 |
| Galena Ditch | 50.20 | 4.81 |
| Provo River: | | |
| Provo Bench | 82.51 | 4.10 |
| East Union | 55.82 | 6.14 |
| Upper East Union | 37.22 | 9.48 |
| Timpanogas | 34.48 | 9.45 |
| Parks & Roberts | 8.15 | [a] 42.06 |
| Lake Bottom Canal | 106 | 3.64 |
| West Union | 74 | 4.92 |
| Roberts Ditch | 19.98 | 12.43 |
| Virgin River: | | |
| St. George and Washington | | 8.41 |
| St. George Clara fields | | 2.74 |

[a] See page 119.

Under most of the canals reported more water was used than is usually considered necessary, showing great opportunity for extending the cultivated area by a more economical use of water.

## CROP VALUES.

The following table gives the acreage values of crops so far as they have been reported. They are given by settlements, most of those reported being in the Virgin River Valley:

*Acreage value of crops.*

| | |
|---|---|
| Weber River: | |
| Summit County | $10.93 |
| Morgan County | 14.70 |
| Davis and Weber counties | 23.86 |
| Virgin River: | |
| St. George and Washington | 22.36 |
| St. George Clara | 21.20 |
| Bloomington and Price | 23.25 |
| Santa Clara | 31.58 |
| Gunlock | 35.00 |
| Pine Valley | 31.60 |
| Grass Valley | 28.12 |
| Harrisburg and Leeds | 30.00 |
| Harmony | 30.30 |
| Kanarraville | 39.40 |
| Bellevue | 32.00 |
| Toquerville | 32.50 |
| Virgin City | 22.50 |
| Grafton | 26.50 |
| Rockville | 28.33 |
| Springdale | 20.25 |
| Bunkerville | 31.53 |

The Virgin River settlements show the larger returns. This is due in a large measure to the higher prices of farm products in the Virgin Valley.

## COST OF WATER.

As has been pointed out, most of the canals of Utah are controlled by stock companies. In most sections of the State the way to get a supply of water is to buy stock in one of these companies. The price of stock naturally has little relation to the cost of the works which furnish the water or to the par value of the stock. It is governed more by the quantity of water which will be furnished and the crops which can be raised. In the table which follows all statements taken from the reports have been reduced to an acreage basis. This is only approximate, as there is seldom any restriction upon the area which may be irrigated with a "share of water." But under each canal there is a general average on which to base calculations:

*Cost of water rights per acre.*

| | |
|---|---|
| Jordan River: | |
| Utah and Salt Lake Canal | $25–$30 |
| South Jordan Canal | 27– 33 |
| North Jordan Canal | 10– 12 |
| Brighton Canal | 4 |

| | |
|---|---|
| American Fork River: Pleasant Grove Canal— | |
| Primary | $15–$25 |
| Secondary | 3– 8 |
| Dry Creek: Alpine— | |
| Primary | 25 |
| Secondary | 15 |
| Virgin River: | |
| St. George and Washington Field | 12– 15 |
| St. Thomas | 20– 25 |
| Overton | 10 |
| Upper Virgin River | 20 |
| Kanab Creek | 40– 60 |

The explanation given of the above table applies to the one which follows. Assessments are levied on the stock of the companies, and these have been reduced to an acreage basis, on the statements made in the reports as to the number of shares of stock usually controlled per acre of land watered. The following table gives the annual cost of water per acre of land watered:

| | *Annual cost of water per acre.* |
|---|---|
| Jordan River: | |
| Utah and Salt Lake Canal | $0.75 |
| East Jordan Canal | 1.50 |
| South Jordan Canal | 1.00 |
| North Jordan Canal | .58 |
| Brighton Canal | .70 |
| American Fork River—American Fork Canal | .40 |
| Dry Creek—North Bench Canal | .40– .50 |
| Virgin River: | |
| St. George and Washington Field | .75 |
| Jarvis Field | 1.50– 2.00 |
| Santa Clara Seep Ditch | .75– 1.00 |
| La Verkin Bench Canal | 1.25 |
| Price Field Irrigation Company | 3.00–10.00 |
| Santa Clara Field Company | .75– 1.00 |
| Gunlock | .50 |
| Pine Valley | .50 |
| Harmony | .50– .75 |
| Bloomington | .15 |
| Toquerville | 1.00 |
| Virgin City | 4.25 |
| Grafton | 1.00– 3.00 |
| Rockville | 1.00– 2.50 |
| Springdale | 1.00 |
| Mount Carmel | .50 |
| Orderville | .60 |
| Glendale | .55 |

## THE FUTURE OF IRRIGATION IN UTAH.

The reports which follow show that the ordinary flow of the streams reported on is already spread over more land than it can properly serve. The same is true of the streams of the State generally. Storage is therefore of first necessity. In his last report, the State engineer,[a] speaking of the plans for the further development of the State, says:

> It is noticeable that only one of these projects * * * has for its object the establishment of a new system. All the other plans are for the preservation and betterment of existing systems. This is truly indicative of the situation and needs of the State as to irrigation. There is little opportunity left for new systems. There is great need of extending and improving the old ones.

The following plans for future development mentioned by the State engineer in his late report are not mentioned in the reports on the various streams:

The Mammoth Reservoir Company plan to provide a supplemental supply of water to lands in the San Pete and Juab valleys, which are now inadequately watered from the Sanpitch River and Salt Creek, respectively. To provide this additional supply the flood and winter waters of Gooseberry Creek are to be stored in Gooseberry Valley and from there conducted by means of a tunnel, about two and one-half miles in length, through the crest of the Wasatch Range and there turned into one of the several streams which are the sources of the Sanpitch River.

At a point some distance down the stream part of the water is to be recovered and conducted in suitable channels along the slopes to the head of Salt Creek, from where, commingled with the creek water, it will enter the system of ditches which now serves the Juab Valley lands. In like manner the unrecovered portion of the water, commingled with that of the Sanpitch, will flow on to the lands of San Pete Valley through the system of ditches which serves the lands of that valley.

Gooseberry Creek is a branch of Price River and a tributary of Green River, and has its source in the immense banks of snow that abound in the hills surrounding Gooseberry Valley. Gooseberry Valley is situated in T. 13 S., R. 6 E., of the Salt Lake meridian, and at an elevation of about 8,400 feet above the sea.

The plan is to convert this valley into a reservoir by means of an earthen dam about 100 feet high, to be built across the narrow gorge through which Gooseberry Creek flows out of the valley. The reservoir so formed will have a capacity of about 25,000 acre-feet. The whole work is estimated to cost in the neighborhood of $400,000. About $70,000 have already been expended in securing the site, for engineering work, and in preparing the foundation. It is a cooperative rather than a speculative proposition, and none but actual users of the waters are subscribers to the capital stock.

The Weber Reservoir, Power and Irrigation Company's plans contemplate, in short, the perfection of the entire Weber River irrigation system. This is the first successful effort to unite the numerous conflicting ditch and district interests, which for the past twenty-five years have been contending one against the other over the apportionment of the Weber River water, into a single compact company for the purpose of common protection and growth.

The execution of these plans involves the construction of at least one dam on each of the several forks of the river to provide reservoir capacity for storing all the flood and winter water of the system. Six of these reservoir sites have already been secured. The two chief dams will be on the main fork of the stream, where considerable preliminary work has been done. One of these dams is planned to be 75 feet in height and 3,300 feet long on top. The surface area of the reservoir so formed will be about 1,600 acres, and the capacity about 40,000 acre-feet.

The stored water will be utilized, first, to supplement the present supply to lands of the system in Summit, Morgan, Weber, and Davis counties, and next in providing water for adjoining lands now wholly without a water right. In effect, the carrying out of these plans will fully insure the present development and permit the greatest extension which the whole supply of water fully utilized will justify.

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[a] Third biennial report of the State engineer to the governor of Utah, 1901 and 1902, Salt Lake City, 1903.

On its passage from reservoir to field the water will, at various points en route, be used to develop power, which will be distributed to desirable points and be used for various purposes of the system. The plans contemplate the full use of all the water of the system for both power and irrigation. It is difficult to foretell the advantages which this double use of the water will bring; but if use for each single purpose is profitable the dual use here contemplated must be doubly so.

Plans for improving Utah Lake as a source of water supply have been discussed in different forms for ten years or more, but nothing worthy of the situation and possibilities has so far been undertaken. Under existing conditions Utah Lake furnishes in ordinary seasons a partial supply of water to about 45,000 acres of land now under the canals that have their source in the Jordan River. In seasons of scarcity the supply is entirely insufficient for this area and great loss in crops results.

The lake and its marshes expose a surface of about 100,000 acres to evaporation, and the loss of water from this cause is more than is needed to fully irrigate all the land in Salt Lake County which lies below the lake level. The plan now under consideration contemplates curtailment of this loss by increasing the depth and decreasing the area of the lake.

It is thought that by segregating from the lake its principal arms or bays, together with the margin of marsh and some strips of shallowest lake along the shore, and filling these segregations with mud pumped from the adjacent lake bottom, a material reduction of surface and increase in depth of water will result. In addition to this it is proposed to raise the lake surface to a higher level by allowing none of the water to run to waste from the lake at any time during any season. There is no doubt but that the filled marshes and lake segregations would be worth as much to Utah County as the increased water supply would be worth to Salt Lake County, and that both counties would be greatly benefited through such work.

Committees have been appointed and are now at work endeavoring to combine and unify existing interests in order to forestall any litigation that might occasion delay. Very satisfactory progress along these lines is being made.

It is proposed to construct an earthen dam about 45 feet high and 600 feet long across the main fork of Strawberry Creek to form a reservoir in which it is proposed to store the surplus water of the creek. The dam will probably be located near the confluence of the two forks and the water of the smaller stream be conveyed into the reservoir by means of a canal, or a dam may be constructed in each fork near their confluence and by this means provide a double basin having a capacity of about 250,000 acre-feet.

It is proposed to utilize the stored water on a tract of about 45,000 acres of land which embraces the cities of Spanish Fork and Payson and the towns of Mapleton, Salem, Lake Shore, and Benjamin in the southern end of Utah Valley. The water is to be brought, in a tunnel about 3½ miles long, through the ridge between Bryans fork of Strawberry and the middle branch of Diamond Creek. The former is a tributary of the Du Chesne River and the latter of Spanish Fork River. From the tunnel mouth the water will be commingled with the Spanish Fork River water and with it be diverted through the present canal system onto the lands which it is to irrigate.

Like the Weber River plan, this is to be a cooperative organization of the people of the several towns and cities to be benefited. The lands which are now deficiently supplied will first be provided with a full supply and the water in excess of this requirement will be used upon the adjoining lands now without water. This is similar to the Weber River plan also with respect to its object, which is not the establishment of a new system, but to combine, preserve, and extend the existing systems.

A committee has been appointed to perfect all necessary preliminaries, and there is every reason to believe that the plan will soon be fully developed and its execution begun.

Various measures for utilizing Bear Lake as a reservoir have been and are now being discussed. Most, if not all, of these contemplate the construction of a canal from 12 to 15 miles in length for conducting the surplus water of Bear River into the lake. It is thought that water to the depth of about 4 feet can be added to the lake without much expense for retaining it, as the natural barriers are nearly or quite sufficient for that purpose. The area of the lake is about 80,000 acres and this depth would afford about 320,000 acre-feet of stored water.

One plan that has been suggested for utilizing the stored water is to conduct it through the mountain ridge in a tunnel, of unknown length, to Cache Valley and there use it on the high bench lands. Another plan is to return the stored water to Bear River by means of a second canal which would discharge the water into the river at a point several miles below the intake of the first or

diverting canal. The water would then be available for diversion by any of the canals which now take water from Bear River below Bear Lake, and could be utilized as supplemental to the present rights or in the reclamation of additional land, or for both. The latter plan would perhaps serve a more extended use than the former.

It is understood that at least two private corporations are now at work upon plans for converting Bear Lake into a mammoth reservoir, and the work will no doubt be accomplished in time.

It is here suggested that the reclamation of the extensive marshes that adjoin Bear Lake should be included in any plan which has for its purpose the greatest saving and utilization of water and the fullest subjugation of land. Both are important matters for consideration in this region, where the ultimate improved area must be small in comparison with the extended area that will remain unimproved.

The Grand River Canal is another important project calculated to increase the water supply of the State. It is proposed to divert the Grand River at a point some distance beyond the Colorado line and bring the water into Grand and San Juan counties of this State for irrigating the large deltoidal tract of land that lies south of the Rio Grande Railway and between the Green and Grand rivers. This will require the construction of a long canal of large dimensions over ground that is badly broken and along slopes that are rough and steep. The cost will be considerable, but it is thought that this will be fully justified by the benefits. The land and location are counted among the best in the State. The soil and climate are well adapted for fruit growing and also for most kinds of farm crops. Transportation facilities are ample, and the situation is said to be of great promise.

The future of irrigation in Utah looks bright. The spirit of compromise, which has been characteristic of the history of the State, is manifest in the plans mentioned by the State engineer, while the law just enacted provides for the settlement of all old controversies, the definition and protection of existing rights, and the orderly acquirement of rights in the future. The law may not do all that is expected of it, but its enactment shows that the people of the State are alive to their needs, and if this law falls short, the spirit which brought about its passage will bring about its modification in such a way as to make it effective.

# IRRIGATION FROM JORDAN RIVER.

By R. P. Teele,
*Assistant in Irrigation Investigations.*

The following discussion of the laws and customs of Utah, as illustrated by irrigation in the Jordan Valley, is based very largely upon the laws of the Territory and State and the public records of Salt Lake County. The fact that these sources do not tell the whole story is fully appreciated, but it is believed that laws published at the time of passage and records contemporaneous with the period under consideration are safe guides when supplemented by an examination of existing conditions and interviews with persons who have had an important part in making the history of the region studied.

## JORDAN RIVER AND VALLEY.

Jordan River heads at the north end of Utah Lake and carries its outflow through the divide into the valley of the Great Salt Lake, to the lands formerly covered by the waters of that lake, but now exposed and forming one of the most fertile and beautiful valleys in the whole Rocky Mountain region (Map, Pl. II). On the east, rising abruptly from the valley, are the rocky, precipitous Wasatch Mountains; to the south, cutting off Utah Lake Valley from Salt Lake Valley, are low spurs of the Wasatch and Oquirrh ranges, apparently meeting where Jordan River has cut its way through; on the west the valley rises gradually to the rounded foothills of the Oquirrh Mountains, while on the north it opens out to the present shore line of the Great Salt Lake. The valley, bounded in this way forms almost a parallelogram some 18 miles wide and 30 miles long, sloping from the mountains on the east and west to the Jordan River and from the south to the lake.

The river is bordered by narrow bottom lands, back of which is an abrupt rise to the bench lands, which form the greater part of the irrigable area of the valley. From the edge of the bench lands near the river, on either side, there is a gradual but quite steep slope to the base of the mountains, limiting the area which can be reached by gravity canals from the river to a comparatively narrow strip down the center of the valley.

Several streams enter the valley from the Wasatch Mountains on the east. City Creek comes in directly behind the city of Salt Lake. To the south are Red Butte Creek, Emigrant Creek, Parleys Creek, Mill Creek, Big Cottonwood Creek, and Little Cottonwood Creek, in the order named, all tributaries of Jordan River, but uniting with that stream too far down to add to the supply of water available from

the river for irrigation. They serve, however, a large area of land which would otherwise depend on the river, and in that way lessen the demand on the supply from Utah Lake. The Jordan has no tributaries from the west, so that the whole west side of the valley depends on the river for its water.

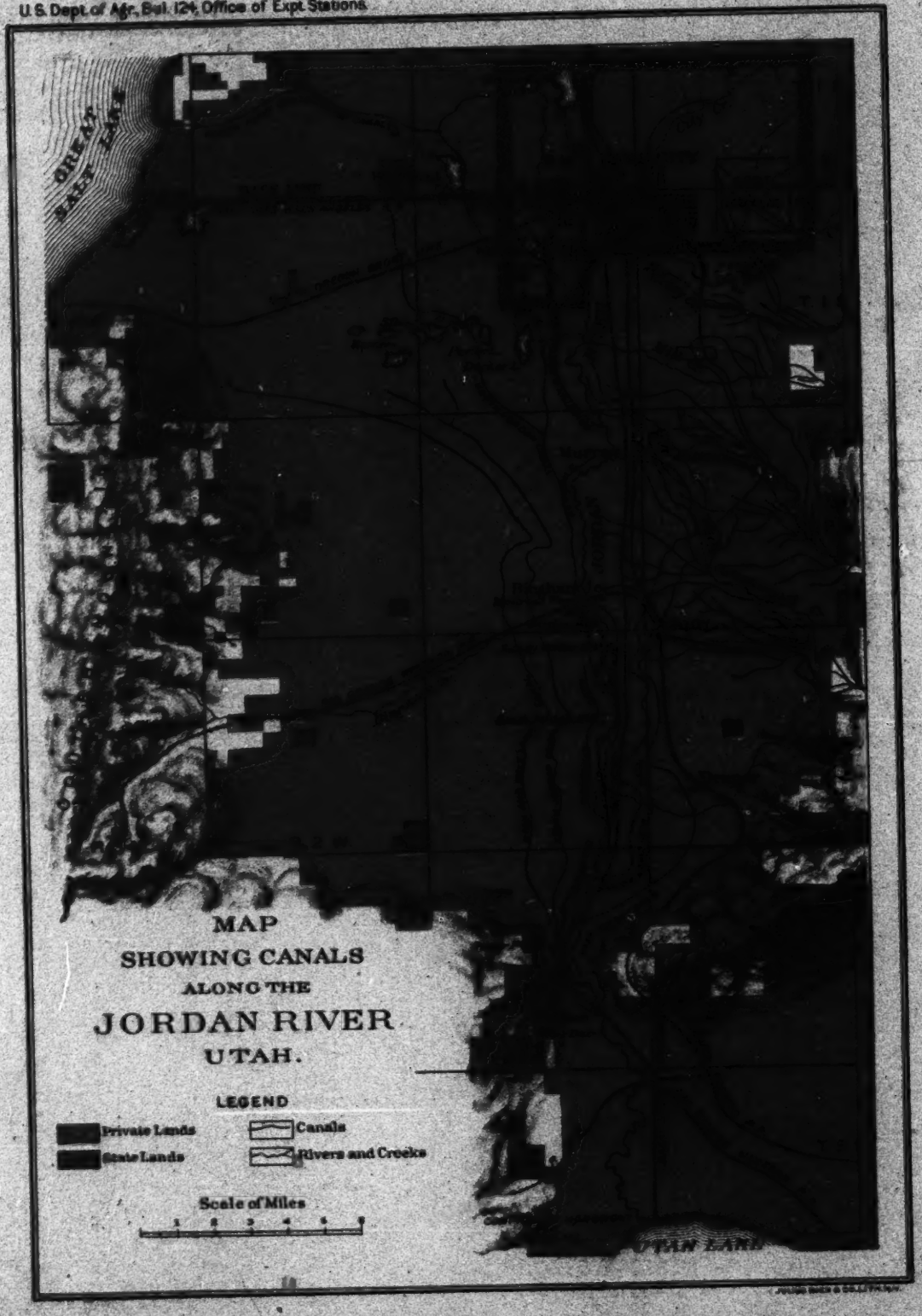
Utah Lake, the only source of supply for the greater part of the Jordan Valley, is a fresh-water body covering at the highest level to which it is raised (see page 64) an area of 93,000 acres, but capable of being raised to a much higher level. The lake is fed by a number of streams rising in the mountains which border its valley on the east and south.[a] The valley of the lake rises gradually from the shores on all sides, forming a rim, through which the Jordan River has cut its way. From its head to the "Narrows," where the foothills from either side close in to form the northern rim of the Utah Lake Basin, a distance of 10 miles by the river, Jordan River has no appreciable fall, while its banks get higher and higher above the stream bed. This topography makes it possible to hold in Utah Lake all the run-off of its watershed by building a dam in Jordan River anywhere between the lake and the Narrows, where every foot of height in the dam gives an added storage capacity of a foot in depth over the entire surface of Utah Lake. The problem of constructing a safe dam, which is the main problem in many storage schemes, does not enter here, since a simple timber structure less than 100 feet long serves to hold all the water which can be brought into Utah Lake (Pl. III, fig. 1).

From the Narrows to its mouth, a distance of 35 miles, the river has a fall of 250 feet, much of which occurs in the first few miles, making it an easy matter to get canals out on the bench lands. The slope of the bench lands from the mountains toward the river is so great, however, that the canals heading in the Narrows parallel the river at a short distance for about 15 miles. At that point the slopes on the west side of the river flatten out and the canals draw rapidly away toward the northwest. The canals on the east side also follow the general course of the river for about the same distance, when they come to the valleys watered by the streams from the mountains, where irrigation extends clear up to the base of the hills. The part of this area depending on the Jordan for water is all the land on the west side of the river which can be reached by canals, and all the land on the east side of the river below the line of the East Jordan Canal and south of the canals from Little Cottonwood Creek.

## DEVELOPMENT OF THE VALLEY.

The first irrigation in the Jordan Valley was not from Jordan River, but from the streams flowing from the Wasatch Mountains on the east. Salt Lake City, the first settlement, is located at the north end of the valley, on the east side of the river, and development began at that place. City Creek was the first stream diverted, and the other streams lying to the south were utilized as the settlement spread. The waters of Jordan River were first diverted in 1850, but for twenty years from that time only small ditches were constructed, although there was no lack of large schemes for making use of the waters of the river. In 1854 a plan for a great navigation, power, and irrigation canal from Utah Lake to Salt Lake was conceived and was

[a] For the water supply of Utah Lake, see report of Mr. Stover, pp. 94, 95.


GREAT SALT LAKE
MAP
SHOWING CANALS
ALONG THE
JORDAN RIVER
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LEGEND
Private Lands
State Lands
Canals
Rivers and Creeks
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formulated in a law passed by the Territorial legislature. No record showing what was done is available, but no such canal was built. The law is quoted in part to show the largeness of the plans at that early day:

SEC. 3. Said canal shall commence above the rapids in Jordan River, where a dam shall be constructed across said river of sufficient height to cause slack-water navigation to Utah Lake, and proceed as near the base of the mountains on the west of Great Salt Lake Valley as practicable, to Great Salt Lake; and shall be of sufficient depth and width for the transportation of boats drawing 2½ feet of water and 12 feet width of hull. There shall also be good and sufficient guard locks, and locks for leveling, and waste gates, as also large reservoirs, with good and sufficient embankments, to contain water for irrigation purposes, at all convenient points.

In 1860 a canal was planned which was to take the water from the Gardner Mill Race, one of the small canals built in 1850, and carry it out on the line now occupied by the North Jordan Canal, but extending farther west. The plan, as outlined in a petition to the county court, was "to take the water of Jordan River at Jordan Mill Dam down the mill race to the mills, thence continuing in the old sect[a] leading to Taylorsville, running west to the point of the mountain."[b] This canal was begun at that time and was extended along that line from time to time up to 1881, when, as the North Jordan Canal, it reached its present size. It has never, however, reached the size originally planned.

In 1862 a charter was granted by the legislature to Brigham Young and others to build a canal from Jordan, heading within the city, about half a mile above the bridge on North Temple street. This company did nothing for a few years, but in 1864 it bought the dam and right of way formerly granted by the county court to F. Little and others, and in 1865 the legislature amended its charter, changing its point of diversion to that occupied by Little. The canal of this company covered land on the west side of the river south and west of Salt Lake City, most of which has since become too strongly alkaline to be used for crops.

In 1864 a large canal was planned on the general line now occupied by the Utah and Salt Lake Canal. On August 17 of that year a mass meeting was held at the Bowery in Salt Lake City, and a committee was appointed to make preliminary surveys. The committee reported in October the survey of a canal 16 feet on the bottom, 3 feet deep, and 32 miles long. The cost of construction was estimated at $250,000. This canal was not built.

So many large plans and such small results led to the passage, in 1865, of the irrigation-district law. The principal features of this law were that it allowed the people of any locality to organize themselves into a company and provided for electing officers, levying taxes, and building and operating canals, under the direction of the county court. The law was approved January 20, 1865. February 2 following, the county court made an order organizing all of Salt Lake County lying east of Jordan River into an irrigation district. Surveys were made and a report made to the county court describing the line of the canal. It was to be 20 feet wide on the bottom, 3 feet deep, and was to cover 24,750 acres.[c] But this scheme, like its predecessors, failed.

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[a] The word "sect," as used in Utah, is synonymous with ditch.
[b] Record of County Court, Salt Lake County, Book B, p. 141.
[c] Ibid., pp. 320–326.

Upon the failure of this irrigation district the legislature chartered a company to build a similar canal for the same territory. The canal was to be used for navigation as well as irrigation, and the company was given the right to divert not to exceed one-half of the water of the river at its point of diversion. Nothing came of this charter.

Notwithstanding the failure of the irrigation district on the east side of the river, the people living on the west side, in 1867, petitioned the county court to organize that part of the county into an irrigation district. The necessary order was made by the court and plans for a canal heading in the Narrows and extending to the Great Salt Lake were adopted. The estimated cost was $300,000 and the area to be reclaimed was 30,000 acres. The money was to be raised by taxing the part of this land which was actually benefited at the rate of $10 to $15 per acre, according to its quality. Like its predecessors, this scheme got no further than the planning.

The real development of the Jordan Valley began in 1870. At that time the South Jordan Canal, one of the four large irrigation canals now in operation, was begun and was completed in 1875. In the meantime the other canals on the west side were also being excavated.

In 1872 the county built what is called the "old dam" (Pl. III, fig. 2), and in the same year began to aid in the construction of canals. In February of that year the county court contracted for the construction of the dam and the excavation of 400 feet of a canal, now the Utah and Salt Lake Canal, the price of the work being $4,700. Later in the same year the county contracted with various parties for the further excavation of the same canal at prices varying from 18 to 23 cents per cubic yard. The "West Jordan Cooperating Irrigation Sect" also received an appropriation of $3,000 and the Bennion Ditch $500. The county continued to make appropriations for canal construction for some five or six years, and aided during that time in the excavation of the Utah and Salt Lake, the South Jordan, and the Brighton canals. The county also built a dam for the North Jordan Canal.

This era of county construction ended in the fall of 1877, and at that time the irrigation-district idea had a great revival. In October the county court received a petition asking that all that portion of the county lying west of Jordan River be organized into one or more irrigation districts. Remonstrances were filed, but during the next two months all the territory under the lines of the canals which had been constructed or projected on the west side of the river was organized into districts. One district included "all that portion of Salt Lake County lying west and south of the South Jordan Canal which can be irrigated by or from the Utah and Salt Lake Canal." The canal, as it was to be extended by the irrigation district, was to irrigate 14,000 acres, at an estimated cost of $5 per acre. Another district comprised the lands under the South Jordan Canal and above the North Jordan and Brighton canals. A third covered the land under the North Jordan Canal. These districts were, however, short-lived, and in 1880 the canal companies as they exist at the present time were organized and incorporated under the general incorporation laws of the Territory for the purpose of taking control of the canals which had been or were being built. The next few years saw the completion of the canals to their present size and length.

While the district plan was being tried on the west side of the river, in 1878 the East Jordan Canal Company was organized and incorporated, and began its canal to cover the land on the east side of the river. This canal is built on the highest possible line from the Jordan River, and covers all the land on that side of the river which can be irrigated by the Jordan, from the Narrows to Little Cottonwood Creek, where it ends.

At the same time that the East Jordan Canal was under construction Salt Lake City was excavating its canal. This canal is on the same side of the river, but on a considerably lower level than the East Jordan. It supplies water for use in Salt Lake City for irrigation and street sprinkling.

The construction of canals from the Jordan ended with the Jordan and Salt Lake City Surplus Canal and the North Point Consolidated Canal in 1885 and the years immediately following. Since that time development has been limited to a greater use of existing canals. A detailed description of the canals at present diverting water from Jordan River is given below. The canals are taken in their order, coming downstream.

## UTAH AND SALT LAKE CANAL.

The Utah and Salt Lake Canal is the highest canal on the west side of the river. It heads at the old dam (Pl. III, fig. 2), in Jordan Narrows, where the first appreciable fall in the river occurs. This dam consists of timber uprights set in cement, between which planks are inserted to raise the water into this and the East Jordan canals.

The discharge of water into the Utah and Salt Lake Canal is controlled by five timber gates working in the timber structure (Pl. III, fig. 1). The canal from the head to the fore bay of the power plant, a distance of about 2 miles, has been enlarged and improved by the Salt Lake City Water and Electrical Power Company so as to carry the entire flow of the river except the water diverted by the East Jordan Canal. The principal improvements are two wooden flumes cutting out curves where large losses from seepage occurred. The first flume, located about one-fourth of a mile below the head of the canal, is 1,200 feet long, 26 feet wide, and 8 feet deep, with floor and sides of 3-inch yellow pine. The second flume, located a mile below, is of the same size and 800 feet long. There are gates at both ends of the flumes for use when, for any reason, it is desired to shut out the water.

At the fore bay there is a second set of head gates for controlling the flow of water from the fore bay into the canal. The water allotted to this canal by the water commissioner is measured in a flume 18 feet wide and 3½ feet deep, located about 1 mile below the power plant. The dimensions of this flume are approximately those of the canal just below the fore bay. The canal has a fall of 16 inches to the mile and an estimated capacity of 250 cubic feet per second.

From its head to the fore bay the canal draws away from the river but a few hundred feet. About a mile below the power plant, however, the course of the canal and of the river changes, the canal turning slightly to the west and the river to the east. In this way the canal gets about 2 miles away from the river, then turns again to the north, and for 10 miles approximately parallels the river at a distance of from 2 to 3 miles. At this point a tongue of high land extends eastward from the mountains on the west and crowds the canal to within a mile of the river. After rounding

this point the canal turns to the northwest and draws rapidly away from the river for the rest of the course, and ends near where the Oquirrh Range loses itself in Great Salt Lake, about 12 miles from the river. The entire length of the canal is 32 miles, and the total area watered is estimated, in the decree of court hereinafter referred to, at 16,000 acres.

The soil varies from a loam, through the sandy loams, to pure sand, the loams predominating under the upper part of the canal and the more sandy soils under the lower section.

### THE EAST JORDAN CANAL.

The East Jordan Canal heads just above the old dam, on the east side of Jordan River, and follows the edge of the narrow bottom lands to the mouth of the Narrows, about 2 miles below the dam. Just below and opposite the power plant the canal turns to the east around a small area of irrigable land, then runs north for a mile, when it once more turns to the east, getting about 2¼ miles away from the river near Draper. Just north of Draper a strip of high ground extends out from the mountains, crowding the canal back to within a mile of the river. The canal then follows the course of the river at a distance of about a mile for 3 miles, nearly to the town of Sandy, where it again turns away from the river in a northeasterly direction and follows that course to where it empties into Little Cottonwood Creek, near Union. The length of the canal is about 16 miles.

The headworks consist of timber gates, raised with a crowbar. The water allowed to the canal is measured in a flume opposite the power plant. The canal is here 15 feet wide and 3½ feet deep and runs on a very light grade. The decreed capacity is 170 cubic feet per second.

The canal covers an area of 12,000 acres, part of which is also covered by canals from Little Cottonwood Creek. A considerable part along the break between the bench lands and the bottom lands is too rough for cultivation, reducing the area which can be watered to considerably less than 12,000 acres.

The soil on the east side of the river is very sandy and is considered a good fruit soil.

### THE SOUTH JORDAN CANAL.

The South Jordan and the Jordan and Salt Lake City canals formerly used a common channel about a quarter of a mile long, heading on the east side of the river, a mile below the old dam. There is a dam at the head of this joint canal, with timber uprights between which there were formerly Cippoletti weirs. Since the building of the power plant the dam is planked up and turns the whole stream into the canal. The head gates are of the usual type. There are four gates, each 5 feet wide in the clear, working between 8-inch timbers.

At the end of the joint canal are head gates in each canal. In the South Jordan Canal there are four gates, each 4 feet 8 inches wide, similar to the ones at the head of the joint canal. The canal crosses the river in a flume a short distance below the point of diversion and remains on the west side of the river the rest of its course. The channel from the head to the power plant is not now in use, as the water belonging to this company is taken through the Utah and Salt Lake Canal and the power plant and turned into the canal just after it has passed through the power house. The

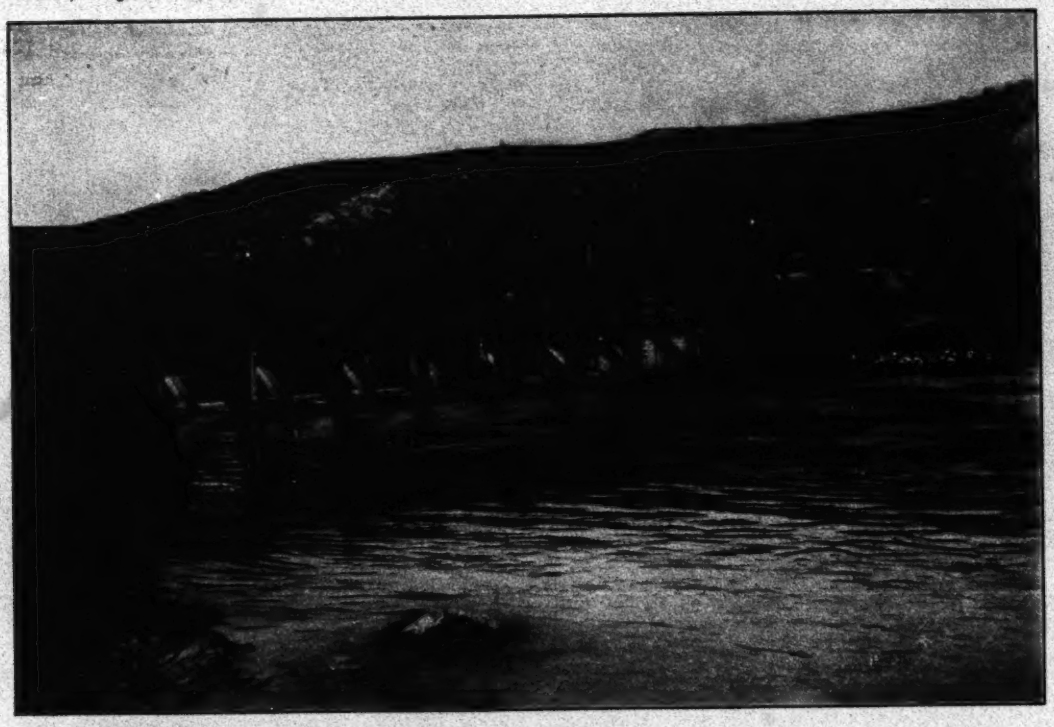

FIG. 1.—NEW DAM IN JORDAN RIVER.

FIG. 2.—OLD DAM IN JORDAN RIVER.

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canal follows the river very closely for a short distance below this point, then gradually draws away, and is almost exactly parallel to the Utah and Salt Lake Canal throughout its entire length of about 18 miles. The average distance between the two canals is about three-fourths of a mile.

For the first 3½ miles below the power plant the South Jordan Canal covers all the land between the canal and the river. At that point the Beckstead Ditch is taken out and covers a narrow strip of bottom land, leaving for the South Jordan Canal a strip a little more than half a mile wide for the next 4 miles. The North Jordan Canal begins where the Beckstead Ditch ends, and leaves a strip of land about a mile wide, on an average, for the South Jordan Canal for the rest of its length. The canal could be used to supply water for a large area of the lowlands south of Great Salt Lake if the water supply were sufficient. The area watered by the canal is reported at 9,000 acres.

The soil under this canal is for the most part a sandy loam, with the exception of a small area of bottom land near the head.

### JORDAN AND SALT LAKE CITY CANAL.

The Jordan and Salt Lake City Canal heads on the east side of the river, at the dam already mentioned in the description of the South Jordan Canal. At the end of the joint canal the Jordan and Salt Lake City Canal has two 10-foot timber gates. These gates are raised by means of iron screws turned by hand wheels. There is a screw at each end of each gate, the two being connected by a sprocket chain so that both screws can be worked by turning either wheel. These gates are not used at present, as no water is left in the river at the old dam except that allotted to this canal.

The canal follows the river very closely for a distance of 3 miles, then flows directly away to the east, until it gets a mile from the river, when it turns again to the north and follows the general course of the river until it reaches the valley of Little Cottonwood Creek. It then draws away to the east and continues to Salt Lake City. The water is not used for farming, but forms a part of the water supply for Salt Lake City.

### MOUSLEY DITCH.

This is a small ditch on the east side of the river, heading about 2 miles below the head of the city canal. It is little more than a mile long and covers less than 100 acres.

### GALENA DITCH.

This ditch is also on the east side of the river, heading about 2 miles below the Mousley Ditch. It covers a narrow strip of bottom land, and furnishes water for power at Bingham Junction, some 7 miles below its head.

### BECKSTEAD DITCH.

The Beckstead Ditch is on the west side of the river. It heads about 6 miles below the old dam, and is about 4 miles long. It furnishes water to the South Jordan Mill and waters a small area of bottom land.

### COOPER DITCH.

The Cooper Ditch is on the east side of the river, some 9 miles below the old dam and about a mile above the head of the North Jordan Canal. It is less than 2 miles long, and is used chiefly to run the Sandy Roller Mill.

### THE NORTH JORDAN CANAL.

The North Jordan Canal heads on the west side of the river, about 10 miles below the old dam. There is a timber dam 36 feet long, which turns the entire flow of the river into the canal. The head gates are a short distance below the dam. There are four timber gates, raised by prying. The North Jordan Canal proper begins about 2 miles below, at West Jordan. The canal to this point is used jointly by the West Jordan Milling and Mercantile Company, the Utah Mattress and Manufacturing Company, and the North Jordan Irrigation Company.

From West Jordan the canal skirts the edge of the bench about 3 miles, being not over a quarter of a mile from the river in this distance. It then turns to the northwest and covers a large area of the lowlands sloping toward Great Salt Lake.

The area claimed to be irrigated by this canal is 8,000 acres and the capacity is given as 150 cubic feet per second.

The upper part of the canal irrigates bottom lands. The soil under the remainder of the canal is generally a sandy loam, much of which is highly charged with alkali. Seepage water from the canals above has ruined considerable land under this canal, and has rendered drainage necessary for a good deal more. Wooden drains are used on much of this land. They are usually made of 1-inch lumber, three 6-inch pieces and one 4-inch piece being used. A trough 4 by 6 inches inside is made of the three 6-inch pieces. Strips are nailed across the top of this trough and the 4-inch piece is placed on top of these strips, leaving an opening for the water to get into the trough. These drains are not expensive and have proved very satisfactory.

### BENNION DITCH.

The Bennion Ditch is on the west side of the river. It furnishes power to a mill at Taylorsville and irrigates a small area of bottom land. The ditch heads about 2 miles above the mill.

### THE BRIGHTON CANAL.

The Brighton Canal heads on the west side of the river about 18 miles below the old dam and 8½ miles south of the city limits of Salt Lake City. The headworks consist of a dam, of the usual type, in the river, and ordinary timber gates in the canal. The canal follows the river for 3 miles, watering a strip of bottom land, then divides, one branch continuing near the river on a strip of land a little higher than that farther away from the stream and the other taking a course away from the stream on a second rise of ground. These branches are each 4 miles long.

While these canals cover a considerable area of land, only a small area is cultivated, as it is too highly charged with alkali to be of use for cultivated crops. Considerable meadow land is watered.

The soil under the east branch is mostly bottom land and that under the west branch is a sandy loam.

## SURPLUS AND NORTH POINT CANALS.

The Surplus Canal was built from a point where the Jordan enters the limits of Salt Lake City, in a northwesterly direction, partly through natural channels, to Great Salt Lake, for the purpose of carrying surplus waters during floods, and to drain a large area of land which was being covered with seepage water. The North Point Canal connects with the Surplus Canal and covers a large area of the level lands lying between Salt Lake City and the lake. Very little of this land has been improved, as it is too strongly alkaline to be farmed successfully under the methods at present employed in this section.

With the exception of the Surplus and North Point canals, which can be ignored so far as land now cultivated is concerned, there has been no canal construction for diverting water from Jordan River since 1883. During all this time, however, there has been a gradual extension of the area cultivated under the canals already built. The area watered by the various canals, as given in a decree of the court defining the rights to water, is as follows:

*Area served by canals from Jordan River as given in decree of court.*

| | Acres. |
|---|---|
| Bennion Ditch | 250.00 |
| Gardner Mill Race | 298.25 |
| North Jordan Canal | 8,000.00 |
| Beckstead Ditch | 530.00 |
| Mousley Ditch | 87.50 |
| South Jordan Canal | 9,000.00 |
| Utah and Salt Lake Canal | 16,000.00 |
| Galena Canal | 322.00 |
| East Jordan Canal | 16,000.00 |
| Cooper Mill Ditch | 145.00 |
| Total | 50,627.75 |

It is probable that the areas given for the small canals are approximately correct, but those given for the large canals are much too large. The areas given would be more nearly correct for the lands which can be reached by these canals, and which would be irrigated if the water supply were sufficient.

As has been stated, the Utah and Salt Lake and the East Jordan canals are built on the highest possible lines on their respective sides of the river. This limits the future extension of the irrigated area to the unimproved lands under the canals now built and the alkaline lands lying to the north of the lands now cultivated, directly west from Salt Lake City. These two fields for extension present entirely different problems. The first is how to obtain an increased water supply, and the second is how to apply an available supply to alkaline lands in such a way as to remove the injurious salts, or at least to keep them from accumulating near the surface in such quantities as to be dangerous to crops. As Utah Lake is the only source of a supply for Jordan River, an increased water supply for the canals now in use means either a larger supply for Utah Lake or increased facilities for storage or both. A few farmers have succeeded in raising crops on the lands west of Salt Lake City, and they claim that others can succeed by using their methods.

## PUBLIC CONTROL OF THE WATER SUPPLY.

The constitution of Deseret is silent as to water rights, but, from the laws enacted under it, the State seems to have assumed the control of all natural resources and disposed of them by legislative grant. In this way certain parties were given control of all the timber in various localities throughout the State; others were given control of travel through the canyons leading into the Salt Lake Valley, with the right to establish toll roads, while others received the right to control certain streams. Thus, in 1850 Ezra T. Benson was granted the "exclusive privilege of controlling the waters of Tooele Valley, Tooele County, known as Twin Springs, also the waters that issue from a spring called Rock Spring, in said valley and county, for mills, and irrigating purposes."[a] Another law, approved the same day, gave Brigham Young control of City Creek, the first stream diverted by the pioneers and now furnishing a part of Salt Lake City's water supply.

A law of Congress approved September 9, 1850, provided for the government of the Territory of Utah. This law, like the constitution of the State of Deseret, made no provision for the control of the water supply, but the Territorial legislature at its first session confirmed all grants made by the State of Deseret and placed all timber and water privileges in the hands of the county court, reserving to itself the right to make special grants. This law is quoted below:

> The county court has control of all timber, water privileges, or any water course or creek; to grant mill sites, and exercise such powers as in their judgment shall best preserve the timber and subserve the interests of their settlements in the distribution of water for irrigation or other purposes. All grants or rights held under legislative authority shall not be interfered with.
>
> Approved February 4, 1852. (Territorial Laws of Utah, chap. 1, sec. 38.)

Immediately after the passage of the law giving the county court control of water privileges, the court passed the following order in regard to petitions asking for the grant of privileges:

> *Be it ordered*, That it shall hereafter be the duty of all or any persons of this county petitioning this court for any right of canyon or location of county road, or any other privilege which by law is made the right of this court to grant, to give public notice of their intention by posting up advertisements of the same in three of the most public places in the county at least ten days previous to the sitting of the court at which time the petition is to be presented.

A further order was made July 31, 1852, requiring that these same notices be published at least twice in the Deseret News.

The county court began at once the granting of rights, principally to the small streams entering the Jordan Valley from the Wasatch Mountains on the east, and the appointing of water masters to control the various ditches which had been built. Thus within five years from the time when the scouts sent out by the Mormon Church first entered the Jordan Valley, the lawmakers had enacted laws providing for the orderly public control and disposal of the water supply. The control of the county court was not, however, exclusive. The legislature retained the right to make special grants. There is no suggestion that rights could be obtained in any other way than by a grant from one or the other of these bodies. There was in this dual control a possibility of conflict, but no such conflicts arose. The records show but one possibile occasion for conflict. January 3, 1859, the county court granted

[a] Laws of Utah, 1850–1870, p. 173.

to F. Little and others the right to build a dam in the Jordan River and take out water on the west side, and a small canal was then built. In 1862 the legislature chartered the Jordan Irrigation Company, which was to water land in the same general locality. The right formerly granted was, however, purchased by the new company. Ten years later a petition for the organization of the same territory into an irrigation district was received, and was refused on the ground that the same tract was included in the grant made by the legislature, and the court had no knowledge of the "disincorporation" of the chartered company.[a]

This dual control continued until 1867, when Congress prohibited all Territorial legislatures from granting special charters.

Between the organization of the Territorial government and 1867 the legislature granted three charters. A law was enacted in 1854 providing for the construction of a navigation and irrigation canal from Utah Lake to Salt Lake. The preamble of the act recites the fact that a large number of the citizens of Great Salt Lake County had subscribed considerable amounts for the purpose of constructing the canal, and proposed to get further subscriptions, and that these subscribers had petitioned that the Territorial government appoint a commission to take charge of the subscriptions and the work of surveying and constructing the canal. The act passed in response to this petition named the members of the commission and described the proposed canal in detail. The commission was charged with surveying the canal and the lands to be benefited by it, and the assigning of lands and water to the subscribers "equal to the precise amount which they have paid, and no more." Four sections of land and all surplus land and water after the awards provided for in the law were to be held for the future disposal by the commission. Reports were to be made to the governor annually, or oftener if required. The canal was not built, but the law shows the relation of the Government to the industrial affairs of the Territory. The people interested were to provide the money, but the work was to be done under public supervision, and the canal was to remain under public control.

In 1862 a charter was granted to the Jordan Irrigation Company. The powers granted to this company are outlined in the portion of the law quoted below:

> The company shall have the entire control and management of all the waters thus taken out, and may use the same for the irrigation of lands, for mills and machinery of any kind, and all other lawful purposes whatsoever; may sell, lease, and dispose of the same or any portion thereof for any or all of the above purposes, on such terms and conditions as the parties may agree; and may levy and collect a percentage on all the lands benefited by said waters or by the construction of the dam belonging to said company.

This was to be a stock company, each share entitling its holder to one vote in all affairs of the company. Public control is not here apparent in the form of the grant, but the fact that the parties to whom the charter was granted—Brigham Young, Daniel H. Wells, Enoch Reese, Wilford Woodruff, and others—were the leaders in both church and secular affairs, makes this company, like the first one chartered, practically a Government affair. The charter also provided that the company should operate only "during the pleasure of the legislature."

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[a] Record of County Court, Salt Lake County, Book B, p. 657.

The third and last charter granted by the legislature was for the Deseret Irrigation and Navigation Canal Company. This company was to build a canal on the east side of Jordan River for irrigation and navigation between Utah Lake and Salt Lake, and was given power to sell water at such rates as could be agreed on, and charge tolls for navigation, the legislature reserving the right to "modify excessive charges for the use of water or rates of toll, and to take such action thereon as the public good may require." Here, again, the parties to whom the charter is granted are the church leaders—Brigham Young, Heber C. Kimball, Edward Hunter, and others—making the chartering of this company virtually the creation of a commission for the construction and operation of the proposed canal. The canal was not constructed.

The action of the county court with relation to the water supply was at first much like that of the legislature, but became later much more intimate, until it culminated in the construction of works by the county and the execution of deeds purporting to transfer title to the water of Jordan River to the canal companies of the valley. In the following pages so much of the record of the county court is given as is necessary to illustrate its attitude toward the water supply.

September 3, 1860, a petition was presented to the court asking for a right to extend a ditch already built—the Gardner Mill Race—and asking further that the court appoint a committee of three to superintend the proposed ditch and appropriate $10,000, sufficient to pay one-half the expense of construction. The petition was granted, so far as the right was concerned, but no appropriation was made. The petitioners were given two-fifths of the waters of Jordan River, provided, among other things, "that nothing herein be so construed as to interfere with any chartered or individual rights previously obtained along the line of said ditch." The charter was further to be subject to any amendment or alteration that might be considered for the good of the community or for the advancement of the enterprise, or that would "vouchsafe individual justice to all concerned."[a] This canal was extended at that time, and has since become the North Jordan Canal, but has never been extended to the limits proposed in the petition.

The court not only exercised a general supervision over canals, as indicated by the above grant, but in some cases went into minor details. June 3, 1861, it granted a right for a small ditch on the east side of the river "upon condition that the sect be made on a straight line * * * and that the grantees make a bridge over said ditch for the accommodation of said Neff and to his satisfaction; and also permit him to take water from said ditch for the benefit of the piece of grass land between the ditch and the river".[b]

The irrigation-district law, enacted in 1865, was an advance in the completeness of the public control of the water supply. Under this law the county court retained all the powers before possessed, and in addition was given supervision of the organization of the proposed districts, and the districts when organized were to report to the court. Taxes for the support of the districts were to be voted by the members of the organization, but collected by public officers in the same manner as other territorial revenues. At one time or another during the fifteen years following the

[a] Record of County Court, Salt Lake County, Book B, p. 152.
[b] Ibid., p. 189.

passage of this law most of the irrigable land in the Jordan Valley was included in districts or proposed districts which got no further than the preliminary steps toward organization. None of the districts accomplished much in the way of canal building, although efforts along that line continued until the repeal of the law.

Up to 1872 neither the legislature nor the county court went further than to grant rights, create commissions, charter companies, supervise the organization of districts, and appoint water masters. As has been seen, the companies provided for included stock companies, corporations for the sale of water, and district organizations composed of those who were to use the water, and who proposed to raise the funds necessary for construction purposes by taxing their property. All these together had accomplished almost nothing in the way of developing the valley. In the year 1872 the county court, apparently despairing of accomplishing results in any other way, began the construction of irrigation works with county funds. February 3 of that year the court made a contract for the construction of a dam in Jordan River, the consideration being $4,700. The same day $3,000 was allowed for work on the "West Jordan Cooperating Irrigating Sect." In June of the same year the court contracted for the excavation of a part of the Utah and Salt Lake Canal, and August 17 of the same year allowed $3,982 on these contracts. From 1872 to 1877 the court continued to make appropriations for canal construction, including work on the Utah and Salt Lake, the South Jordan, the Bennion, and the Brighton canals. In 1880, when the canal companies which now control these canals were incorporated, the court appointed committees to look up the records and see how much had been spent in this way and to devise means of recovering the money. The committee on the South Jordan Canal reported that $35,122.36 had been spent on that canal. Some of this was repaid in money, some in stock in the canal company, which was later sold by the county, and some of it was canceled in accordance with a compromise agreement between the county and the canal company. A similar examination made in 1885 showed that the county spent $33,949.94 on the Utah and Salt Lake Canal, and a compromise settlement was made.

During this time the court continued its supervision of the use of water by the canals already built, appointing water masters and settling disputes between the parties. The methods adopted by the court are illustrated by the following references to the minutes of its proceedings: December 3, 1872, some differences between water users being brought to the attention of the court, it was ordered "that the selectmen visit the place and settle the matter between them." September 13, 1879, A. Gardner came before the court and complained that the Cooper Mill and the Galena Smelter were taking all the water, so that his mill could not run. A committee was appointed to go with Gardner and confer with the others in regard to the use of the river for milling.

The control of the water supply by the county court nominally came to an end in 1880 with the passage of a law making the county selectmen ex-officio water commissioners. Two days before this law went into effect the court made an order granting all the water of Jordan River to the five large canals which had been begun at that time and which to-day serve most of the land watered by the Jordan River.

The law of 1880 was not revolutionary in its character. The county court was not in reality a court, but was a board having charge of the county business

corresponding to the present board of county commissioners. The court included the county selectmen and the probate judge. The only change made by the new law, so far as the board controlling the water supply was concerned, was the dropping out of the probate judge. The law, however, defined the duties of the board of water commissioners somewhat in detail, the most notable feature of the law being the provision for the issue of certificates to persons having rights to water. However, the language of the law was such as to lead to its being considered void. The section of the law which is held to have conflicted with the organic law of the Territory is given below:

* * * and to receive, hear, and determine all claims to the use of water, and on the receipt of satisfactory proof of any right to the use of water having vested, to issue to the person owning such right a certificate therefor for recording and to generally oversee in person, or by agents appointed by them, the distribution of water within their respective counties, from natural sources of supply, to all corporations or persons having just rights in and to any natural source of supply, and to fairly distribute, according to the nature and extent of recorded rights, and according to law, to each of said coporations or persons, their several portions of such water; and in case of dispute between any such persons or corporations as to the nature or extent of the rights to the use of water, or right of way, or damages therefor, of any one or more of such persons or corporations, to hear and decide upon all such disputed rights, and to file a copy of their findings and decisions as to such rights with the county recorder, and to distribute the water according to such findings or decisions, unless otherwise ordered by a court of competent jurisdiction.

The law further provided for the appointment of intercounty boards to control streams which extended beyond the limits of a single county.

The section above quoted was held to give judicial powers to a court not mentioned in the section of the organic law of the Territory which enumerated the courts, and the law has, therefore, been generally held to be void, although the question was never brought before the supreme court of the Territory.

As has been shown, the county court had been exercising all the powers enumerated in this law, except the issuing of certificates, and its action had apparently been acquiesced in by all concerned. The law apparently contemplated but this one change in the existing system, and that change was undoubtedly a wise one. Up to that time there had not been sufficient development in the Jordan Valley to make the question of the extent of water rights a matter of any great consequence, or to occasion any serious conflicts over water, but the lawmakers saw the possibilities of future conflicts and provided means for making all rights a matter of record before such conflicts arose, and for settling differences as to the nature of the rights, which could not be anticipated, and were, therefore, wisely left to be settled as they arose. The law was never put to the test of use, but it contains several features which, if enforced, would be a great advance on any system yet enforced in Utah. The law was weak in that it made no provision for the granting of rights, but left them to be acquired by appropriation. It did, however, make provision for the issuance of certificates of all rights acquired and the recording of these certificates so that all rights to water should be a matter of public record, open to all interested parties. It further provided an easy means of adjusting disputes over water rights, and for the protection and enforcement of acquired rights. Never since the passage of this act has Utah had a system which had so many good features as the one provided for. It is to be regretted that the law was held to infringe upon the prerogatives of the

court. Otherwise we might have to-day in Utah complete records of all rights to its streams, and the water commissioners would have some basis to work on in dividing the water in their districts.

So far as the records of Salt Lake County show, the court of that county paid no attention to this law, but continued to control the streams as it had done for nearly thirty years. The most important action taken was the deeding of the water of the Jordan River to the canal companies. April 14, 1883, the court deeded to Salt Lake City, the East Jordan Irrigation Company, the Utah and Salt Lake Canal Company, the South Jordan Canal Company, and the North Jordan Irrigation Company each a one-sixth interest in the dam in Jordan River built by the county, and in the waters of the river, leaving one-sixth to be disposed of later. September 22, 1885, the court agreed to deed this remaining one-sixth of the dam and river to the Hydraulic Canal Company, "on the incorporation of that company." This company never built its canal, and in 1888 the court ordered that the interest in the canal formerly deeded to the Hydraulic Canal Company be deeded to Salt Lake City.

From this time the participation of the court in irrigation affairs naturally grew smaller, as it had granted rights to most of the water of the county, but as late as the fall of 1895 the members of the court continued to act as water commissioners and grant rights to the streams of the county whenever occasion for such action arose. With the admission of Utah as a State in 1896 the county court went out of existence.

In the convention which drafted the constitution for the State of Utah an attempt was made to provide for an efficient system of public administration of the water supply. This attempt failed, chiefly because of the fear of the people that the adoption of such a system would in some way curtail their rights, or perhaps confiscate them entirely. After a great deal of discussion the whole subject of irrigation was omitted from the constitution, except for a clause recognizing all existing rights to water. This left the new State without any provision for the acquirement of water rights, or any means of protecting existing rights except through the courts.

The legislature of 1897 provided for the filing of claims to water and for the recording of statements of rights already acquired, but made no provision for any public inspection or supervision of the filings made or for any public officers for protecting rights. This law left the water supply still without any public control, outside the courts, but made provision for the settlement of water rights in the courts by providing that "in any action for the protection of water rights plaintiff may make all persons who have diverted water from the same stream or source parties to such action, and the court may in one judgment settle the relative priorities and rights of all the parties to such action."[a]

A bill providing for a State board of control to adjudicate water rights and for the appointment of commissioners to distribute the waters of the State among appropriators, "according to the prior rights of each," was introduced in the legislature in 1901. The provision for the board was not enacted, but that empowering the boards of county commissioners to appoint water commissioners was carried. Under this law two commissioners have been appointed in Salt Lake County, one for the streams entering the Jordan Valley from the east and one for the Jordan River. These commissioners have acted during the seasons of 1901 and 1902.

[a] Revised Statutes of Utah, 1898, section 1274.

A review of the preceding pages shows that Utah began with absolute public control of the water supply, which culminated in the construction of canals by the county and the deeding of the water of Jordan River to the owners of the large canals diverting it. From 1883, when these deeds were executed, to 1896, when Utah became a State, there was a gradually diminishing participation in irrigation affairs by the county court. From 1896 to the present time there has been a growing sentiment in favor of a return to some system of public control. Such a proposition was defeated in the constitutional convention on the ground that water was the absolute property of those who used it, and the State had no right to interfere in any way. The law of 1901, above referred to, providing for the appointment of commissioners to divide the water, admits the right of the State to control the water of streams, and is, therefore, a long step toward a satisfactory system of water laws.

At present the public authorities have nothing to do with the initiation or establishment of water rights or with controversies regarding rights. The person wishing to acquire a right must post and file a notice of his intended diversion, and then build his works. He may file any kind of a claim he chooses and may proceed unmolested by any public officer until some one claims to be injured by his acts, when the courts will take the matter up. When a right has been defined by a court the commissioner will recognize it in distributing the water. He may or may not do so before, as he sees fit. This leaves the whole matter of water rights in an unsettled condition, since new canals can be built at any time, and so upset all that has been done toward quieting titles to a stream.

## RIGHTS TO WATER FROM JORDAN RIVER.

The foregoing discussion of public control of the water supply shows that rights were obtained from two sources, the Territorial legislature and the county court. In addition there are a few small canals for which no grants were made, but which have been recognized as having rights, making a third class, rights by appropriation.

### RIGHTS BY LEGISLATIVE GRANT.

The only canal diverting water from Jordan River which can trace its right back to a legislative grant is the Brighton Canal. The Jordan Irrigation Company, chartered in 1862, extended a canal already built, and after several changes this canal has become the Brighton Canal of the present time. The right of this company has never been defined as to volume, and has never been brought into question in the courts. There is, however, no question of the right of this company to divert water from the river, because of its undisturbed use of the water for such a long series of years. Since the construction and use of the canals higher up the valley the return seepage from the irrigated lands has maintained an abundant supply of water at the head of this canal at all seasons of the year.

The other companies chartered by the legislature failed to build canals and hence acquired no rights. The grant to one of these companies was for "not to exceed one-half the water in the river at its point of diversion." The other specified no volume.

## RIGHTS GRANTED BY THE COUNTY COURT.

Immediately after the passage of the law giving the county court control of water privileges, the court began the granting of rights, principally on the smaller streams of the county. The first right to water from the Jordan River was granted by the court in September, 1852, to Zera Pulispher and others. In 1856 Thomas Callister was granted a right, and in 1858 the same party again came before the court and was granted a right to make a dam in Jordan River opposite Salt Lake City, provided he got the concurrence of the city council. No canals were built under any of these grants.

January 3, 1859, Ferimortz Little and others were given the right to make a dam across Jordan River at or near John Bennion's farm for the purpose of taking out the water on the west side of the river for irrigation. A dam was built and the ditch taken out a few miles. This ditch was purchased by the Jordan Irrigation Company, chartered by the legislature and referred to above. The Brighton Canal now occupies the line of this early ditch, and Little's successors take their water from that canal.

September 7, 1860, the court ordered "that the exclusive right to take out two-fifths of the water of the Jordan River through the mill-race of A. Gardner & Company by way of Taylorsville to the point of the mountain west be granted to A.. Gardner, R. Miller, Jesse Fox, and Ira Eldridge for irrigating purposes; provided that this be carried into effect by the first day of January, A. D. 1863." The canal for which this right was granted has developed into the North Jordan Canal of the present time, but it has not yet been extended to the point mentioned in the grant, so that it is doubtful whether the North Jordan Canal Company could base any claim on this grant, even if it had not waived all such claims, as it did in an agreement with the county court, entered into in 1883, and discussed later.

January 3, 1861, the claimants of the Tenth Ward Survey petitioned the court "for the privilege of making a water sect across a portion of Mr. Neff's survey on Jordan, commencing at some suitable point on Jordan and running to the north end of said survey." The court granted this petition, but the canal proposed to be constructed by the petitioners was not taken out.

As has been stated, the county of Salt Lake, through the county court, began, in 1872, aiding in the construction of canals on the west side of the river. What is known as the "old dam" was built by the county, and money was expended on the Utah and Salt Lake, the South Jordan, the North Jordan, the Brighton, and the Bennion canals, but no formal grants of rights to water were made at that time, although participation in the construction of the canals by the body which had the granting of rights might be construed to be a grant.

In 1877 a petition was received from the organizers of the East Jordan Canal Company asking for the right to take water from the Jordan at or near the dam which had been built by the county in the Jordan Narrows. Upon consideration the court ordered that the petitioners should have the right to take water out, not to exceed one-fourth of the water of the River Jordan.[a] This canal was carried forward to completion within the next few years, but the company, like the com-

[a] Record of County Court, Salt Lake County, Book C, p. 377.

panies owning the other large canals from Jordan River, waived all claims to priority in the agreement with the county court previously referred to.

On petition the court ordered, September 1, 1879, that G. B. Wallace and others have the right to take water from the Jordan River, near the residence of George Q. Cannon, in Farmer's Precinct, and convey it to their land in the northwest portion of Salt Lake City corporation. This scheme was never carried out.

In 1880, two days before the approval of the water-right act of that year, the county court made a division of the water of Jordan River, defining the rights of the canals heading in the Narrows, but not mentioning the canals heading farther downstream.[a]

The order recites the fact that the East Jordan Canal had been granted one-fourth of the water of the river at the dam built by the county, and gives the West Jordan Irrigation Company the right to take three-sixteenths of the water at the same point through the Utah and Salt Lake Canal. The South Jordan Canal and the Jordan and Salt Lake City Canal were each to take one-third of the water in the river at their joint point of diversion about 1½ miles below the dam. As will be seen, this order gives the Utah and Salt Lake and the East Jordan canals seven-sixteenths of the water of the river at the dam, leaving nine-sixteenths in the stream. The South Jordan and the Salt Lake City canals are each given one-third of what is left, or three-sixteenths of the flow at the dam, making the claims of each equal to that of the Utah and Salt Lake Canal, and leaving three-sixteenths of the flow at the dam in the river for the canals heading below. That is, the stream is divided into five approximately equal parts—one part going to each of the four canals and one part remaining in the river.

The same day a mill right which had never been used was granted to Angus M. Cannon, the mill to be located about 1½ miles north of the head of the South Jordan Canal, and the water to be taken out through that canal.

The county court again took up the consideration of the rights to Jordan River in 1882, and later deeded the water of the river to the five large canals diverting the water. The deeds state that the county had built the dam in Jordan River, and that the Utah and Salt Lake, the North Jordan, the South Jordan, and the Jordan and Salt Lake City canals had been completed and were in full operation, and the East Jordan Canal was nearly completed and would soon be ready to receive and carry water; and, further, that questions as to the extent of the rights of the several companies had arisen, and that a meeting of representatives of the canal companies and of Salt Lake City and the county court had been held to consider these questions, at which the following proposition was made:

> A proposition was made on the part of the county court to the effect that Salt Lake City and said East Jordan Irrigation Company, the Utah and Salt Lake Canal Company, the South Jordan Canal Company, and the North Jordan Irrigation Company were equally interested in the waters of Jordan River and in the construction of said Jordan Dam for the storage of water whenever necessary, and the control and distribution thereof for irrigation purposes, and were entitled to an equal proportion of said water, and that Salt Lake County, the constructor and owner of said dam should convey and transfer to Salt Lake City and to each of said canal or irrigation companies an undivided one-sixth interest in said dam, together with the one-sixth part of the water of the river, at that point, to be

[a] Record of County Court, Salt Lake County, Book C, pp. 717, 718.

taken out of the said stream into the said canals owned by the said companies, respectively, the county to retain one-sixth interest in said dam, and one-sixth part of the water at that point to be used for such purpose or purposes as may be deemed for the best interest of the public hereafter; which proposition was unanimously accepted by the said trustees and representatives of the said companies, and thereupon it was then and there agreed between the said trustees and representatives, respectively, that upon the compliance on the part of Salt Lake County with said proposition by transferring and conveying to the said companies each the undivided one-sixth part or interest in said Jordan Dam, and the right of each to the one-sixth part of the water of the river to be taken out as aforesaid at any and all times, the claims of the said companies or either of them to priority of right to said water in the event there should not be a sufficiency at all times to supply the demand therefor, should be withdrawn, and no such claim should ever be made in the premises by either of said companies or corporations, but each of said companies having the unquestioned right to the same, shall at any stage of the river have the right to take and use the one-sixth part of what may at that time be in the river flowing from Utah Lake.[a]

The power of the county court to give these deeds has been questioned. The county built the dam and paid for its maintenance, and there can be no question as to its power to deed that to the canal companies, but there would seem to be no authority for the deeding of the water. Under the former grant to these companies each company, except the North Jordan, received about one-fifth of the water of the river. Under this agreement they were to waive all prior claims and take one-sixth each.

The one-sixth interest in the dam and river which was retained by the court in 1883, was granted by the county to the Hydraulic Canal Company in 1885.[b] This company did nothing, and in 1888 the probate judge was ordered to deed to Salt Lake City the one-sixth interest in the dam and river formerly deeded to the Hydraulic Canal Company.

In this way the court disposed of the entire flow of Jordan River, regardless of the fact that there were ditches taking water from the river all along its course from a few miles below the dam to the southern limits of Salt Lake City. No further action regarding rights to Jordan River has been taken by the county court.

All the rights thus granted, which were made effective by the construction of canals, except that to F. Little, now utilized through the Brighton Canal, were adjudicated in the district court in 1901, and are discussed later.

## RIGHTS BY APPROPRIATION.

Between 1850 and 1880, when the county court made its first order regarding the division of the water of the river, there were a number of ditches constructed which are seemingly ignored by that order, unless the three-sixteenths of the flow of the river not disposed of at that time was retained for their use. The later division, when the county deeded the water of the river to the city and the canal companies, certainly ignored these rights, since the deeds expressly state that the county was "to retain one-sixth interest in said dam and one-sixth part of the water at that point, to be used for such purpose or purposes as may be deemed for the best interest of the public hereafter." This question was, however, of more theoretical than practical importance, since in most years there has been enough water for all, and the return seepage would have supplied enough water at the heads of these

[a] Deeds, Book W, p. 98. [b] Record of County Court, Salt Lake County, Book D, p. 638.

ditches, even if the canals heading in the Narrows had taken all the water to which the court supposedly gave them title. These rights are defined in the decree of the court above referred to.

### CLAIMS FILED IN THE OFFICE OF THE COUNTY RECORDER.

From 1889 to the present time there have been filed in the office of the county recorder of Salt Lake County claims to the water of Jordan River, although there was no law for filing such claims until 1897. The first of these is a notice filed January 30, 1889, by the North Point Irrigation Company and the West Point Canal Company. They claim sufficient water to fill a ditch 20 feet wide and 5 feet deep, to be taken out near the head of the Surplus Canal, and probably through that canal. These companies have since combined under the name of the North Point Consolidated Irrigation Company, and have built a canal connecting with the Surplus Canal, which heads near the bridge on Twelfth South street, Salt Lake City. The filing of the claim would of itself give them no right to water, but the building of the canal and the use of the water has undoubtedly given them a right, although its amount has never been defined. There is always plenty of water in the river at the head of the Surplus Canal, although the entire flow is taken out above. Under these circumstances there is not likely to be any controversy over the right of this company.

June 10, 1891, E. P. Sears and W. E. Robinson filed a claim to 200,000 miner's inches or 4,000 cubic feet per second of the water of Jordan River, to be taken out at the outlet of Utah Lake, "by means of head gates 200 feet in width and 8 feet in depth, and canals, flumes, pipes, and other aqueducts conveyed to the points of use." This scheme was never carried out.

December 3, 1893, Charles Wilkes filed a notice claiming 20,000 cubic feet per minute of the water passing the dam of the Utah and Salt Lake and East Jordan canal companies, for the generation of electricity, the water to be returned to the river above the dam of the Jordan and Salt Lake City and the South Jordan canals. December 20, 1893, the same man filed a like notice, changing the volume claimed to 25,000 cubic feet per minute, and the water to be returned to the river, the point not being specified. Nothing more was done in the matter and no rights vested.

May 28, 1894, G. W. Stevenson and E. P. Sears claimed all the unappropriated water in the Jordan River to be taken from the river in the northern part of Salt Lake City. There is a good supply of water in the river at this point, but no canal has been built to utilize it.

April 4, 1896, the Bingham Tunnel Company claimed all the water of Jordan River at the heads of the Utah and Salt Lake and East Jordan canals, subject to the rights of those companies, for power purposes. This claim was not followed by any construction, and lapsed.

April 11, 1896, E. W. Taylor filed claims to the water diverted by all the canals heading in the Narrows, the water to be diverted through those canals. In January, 1898, Taylor transferred to Allen G. Lamson whatever rights he had acquired by filing these claims.

May 4, 1897, C. M. Dull filed a notice claiming the water of Jordan River at the dam for power purposes, except the water appropriated by the Utah and Salt Lake and East Jordan canals. June 4, 1897, C. W. L. Stevens filed a like notice, and

December 11, 1897, Allen G. Lamson filed a third notice claiming the same water; and, in addition one-sixth of the natural flow of the river, stating that Salt Lake County claimed to hold one-sixth when it deeded away five-sixths of the flow of the river to the canal companies, and that the county had no right to hold this water. Later both Dull and Stevens transferred their interests to Lamson, and Lamson in turn transferred to the Salt Lake City Water and Electrical Power Company. In 1899 this company enlarged the Utah and Salt Lake Canal for a distance of about 2 miles from its head and built an electrical-power plant to be run by using all the water of the river except that belonging to the Utah and Salt Lake and East Jordan canals. The water was to be delivered to the city and the South Jordan canals, and to the river below the power plant. The right of the power company is defined in the decree heretofore referred to, and discussed later.

August 5, 1897, H. T. Spencer claimed 1,000 cubic feet of water per second, to be used along the line of the Utah and Salt Lake Canal, but later transferred his right to that canal. This claim was purely speculative, as the volume claimed far exceeds the maximum flow of the river.

October 15, 1898, A. Gardner claimed 2,500 cubic feet per minute of the water running past the tailrace of the West Jordan Mill for running a roller flouring mill and for other purposes. This claim has been allowed to lapse.

August 22, 1900, Harry S. Mayetts claimed 75 cubic feet of water per second, to be taken out near the corner between sections 20, 21, 28, and 29, T. 2 N., R. 1 W. This point of diversion is very near the mouth of the Jordan and so far down that seepage will always supply the necessary water in case a canal is built to utilize it.

## DECREED RIGHTS.

In January, 1901, several suits relating to water rights on Jordan River were pending, in all of which the Salt Lake City Water and Electrical Power Company was a party. These suits were consolidated and the whole matter of rights to water from Jordan River was taken into consideration by the court, evidence being taken as to the date of construction, area irrigated, and duty of water in the different parts of the valley. The following table summarizes the statements in regard to these matters, made by the court in its findings of facts and decree:

*Summary of decree settling water rights on Jordan River.*

| Name of canal. | Date of construction. | Area irrigated. | Volume decreed. | Area per cubic foot per second. |
|---|---|---|---|---|
| | | *Acres.* | *Cubic feet per second.* | *Acres.* |
| Bennion Ditch | 1850 | 250 | 5 | 50 |
| Bennion Mill | 1880 | ..... | 40 | ..... |
| Gardner Mill Race | 1850 | ..... | ..... | ..... |
| John Egbert | ..... | 15 | | |
| Albine Beckstead | ..... | 31 | | |
| Hyrum Beckstead | ..... | 22 | | |
| John Bailey and H. Dinwoody | ..... | 70 | 5.5 | 55.3 |
| W. L. Egbert | ..... | 13 | | |
| D. A. Egbert | ..... | 19.75 | | |
| Solon Richardson | ..... | 90 | | |
| Ludwig Christensen and John Peterson | ..... | 32.50 | | |

*Summary of decree settling water rights on Jordan River*—Continued.

| Name of canal. | Date of construction. | Area irrigated. | Volume decreed. | Area per cubic foot per second. |
|---|---|---|---|---|
| | | *Acres.* | *Cubic feet per second.* | *Acres.* |
| Gardner Mill Race—Continued. | | | | |
| West Jordan Milling and Mercantile Company | 1850 | | 20 | |
| Utah Mattress and Manufacturing Company | 1851 | | 11 | |
| Galena Canal | 1855–1873 | | | |
| A. W. Smith | 1858–1877 | 70 | 2.825 | 67.3 |
| James and Charles Blake | | 80 | | |
| A. C. and A. D. Lunner and W. R. Wellington | | 35 | | |
| Henry Osborne | | 27 | .84 | 50 |
| Sarah E. Stewart | | 90 | 1.40 | 64.2 |
| John T. Wilson | | 15 | .30 | 50 |
| United States Mining Company | 1873 | | 17 | |
| Beckstead Canal | 1859–1863 | 580 | [a]12 | 44.2 |
| South Jordan Mill | 1896 | | [b]23 | |
| Mousley Ditch | 1864 | 87.50 | 2 | 43.8 |
| Cooper Ditch | 1878 | | | |
| John Neff | | 70 | 1.40 | 50 |
| Anna E. Neff | | 60 | 1.20 | 50 |
| John T. Wilson | | 15 | .30 | 50 |
| Sandy Roller Mill | | | 23 | |
| North Jordan Canal | 1859–1881 | 8,000 | [c]120 | 66.7 |
| South Jordan Canal | 1870–1875 | 9,000 | [c]142 | 63.4 |
| Utah and Salt Lake Canal | 1872–1882 | 16,000 | [c]246 | 65 |
| East Jordan Canal | 1877–1883 | 16,000 | [c]170 | 94.1 |
| Jordan and Salt Lake City Canal | 1879–1882 | | [c]150 | |

[a] Given 4 cubic feet per second in winter.

[b] Water returned above all ditches heading below Beckstead.

[c] Capacity of canal, not volume decreed. The five canals last named divide equally whatever water is left after the other rights enumerated in the table are supplied.

The court, after enumerating the rights as set out in the above table, except those of the five large canals and the South Jordan Mill, defines the rights of the large canals as follows:

That the plaintiffs, Salt Lake City, a municipal corporation, and the Utah and Salt Lake Canal Company, a corporation, and the defendants, East Jordan Irrigation Company, South Jordan Canal Company, and the North Jordan Irrigation Company, corporations, are the owners of the right to the use of all of the balance of the waters of the Jordan River, for municipal, irrigation, culinary, and domestic purposes, to the extent of the capacity of their several canals, and of the right to impound and store all of the waters of said river in Utah Lake, subject to the limitations hereinafter set forth.

That the said city and canal and irrigation companies shall at all times allow to flow unimpeded down through the channel of said river a sufficient quantity of said waters which, when added to the accretions to the river from seepage and other sources, will furnish at the various points of diversion and measurement the several quantities of water herein awarded to the West Jordan Milling and Mercantile Company, the Utah Mattress and Manufacturing Company, The United States Mining Company, William Cooper, jr. (Sandy Roller Mill), and Bennion & Bennion, for the operation of their several mills and factories; and during the irrigating season of each year shall allow to flow unimpeded through the channel of the river such additional quantity of water as will, when added to the accretions from seepage and other sources, supply at the various points of diversion and measurement the quantity of water herein awarded to the several farmers and landowners taking water for irrigation purposes through the Gardner Mill Race, the Galena Canal, the Beckstead Irrigation Company's Canal, the

Mousely Ditch, Bennion & Bennion Mill Race, and the Cooper Mill Race, as hereinafter set forth; and during winter or nonirrigating season, 4 cubic feet of water per second for the use of the stockholders of the Beckstead Irrigation Company for domestic and culinary purposes. * * *

That subject to these limitations and to the limitations contained in the agreement of compromise entered into in 1885, between Joseph H. Colladge and others and said city and canal and irrigation companies, the said city and canal and irrigation companies have the right, at all times, to shut off, impound, and store the entire flow of the Jordan River and hold and save the same for future use, to the extent which, in their judgment, their interests may require, and as between themselves (the four canal companies and the city) shall have an equal right to the use of all such waters, to the extent of the capacity of their several canals, and while there is sufficient water for that purpose may each take the full quantity of water their respective canals will carry, and when the water is insufficient to fill all the canals to their maximum capacity, then the city and canal and irrigation companies shall be entitled to an equal division thereof, provided, that if by such division one-fifth of the water should exceed the capacity of any of the canals, such excess may be used by such remaining canals as have the capacity to take the same in equal proportion; and during the winter or nonirrigation season, each of said canal companies shall have the right to the use of 10 cubic feet of water per second of time in their several canals, for the use of their stockholders for culinary and domestic purposes.

The South Jordan Milling Company is given the right to use 23 cubic feet per second through the Beckstead Ditch.

The Salt Lake City Water and Electrical Power Company is awarded the right to use the water belonging to the canals heading below its plant and return the same to the river; also the right to use the water of South Jordan Canal so long as its contract with that company shall remain unrevoked; also to use the city's water so long as the city continues to divert its water at its present point of diversion; "provided, however, that the right of the said (power company) to so take and use the city's said water shall be effective only after said power company establishes by judgment of the court in an action at law its rights to make connections with its flume and the said city's canal, and shall have paid to said city any sum which may be awarded to said city by way of damages therefor." The same provision is made in regard to the South Jordan Canal in case the contract is revoked. The power company is to deliver water from its tailrace to the canals in proper proportion, as shall be determined by those authorized to divide the water.

The rights of the canals heading below the tailrace of the Bennion Mill are not included in the decree. There are but two canals heading in that part of the river, the Brighton and the North Point Consolidated canals. As has been stated, return seepage and the tailraces of the mills furnish an abundant supply of water for these canals, so that the taking out of all the water above does not prevent their getting all they can make use of.

The water-right law of 1897 recognized rights acquired by appropriation and use, and the court in the above decision seems to have recognized no other kind. Neither in the findings of fact nor in the decision is there any mention of grants by the legislature or the county court, or the deeds executed by the county court. All the rights which antedate those of the large canals are based on testimony as to date of construction and area irrigated, while those of the large canals are based on the practice, of twenty years standing, of dividing the water equally among themselves. So far as the decision of this case is concerned, there may as well have been no irrigation laws in the State of Utah for the past fifty years. This is not saying that the laws have not served a useful purpose. The supposition that the county

court had authority to control water matters certainly prevented a great many conflicts. There are cases on the smaller streams in Salt Lake County where the court denied petitions for water rights on the ground that all the water in the stream in question had been previously granted. The court appointed water masters to divide water among conflicting claimants, and in some cases made regular adjudications, taking testimony, chiefly as to area irrigated, and defining the rights of the various claimants, generally in fractional parts of the stream. In fact, the law of 1852, giving the county court control of water privileges, as it was enforced in Salt Lake County, was nearly up to the highest development in irrigation law of the present time, and the fact that it was entirely ignored in the recent adjudication does not reflect on its usefulness.

Since the rendering of the decree several claims to water from Jordan River have been filed. August 9, 1901, the North Jordan Irrigation Company filed a claim to the water decreed to the West Jordan Milling Company and the mattress factory at such times as those concerns are not using it. The canal company has had the use of this water at such times for many years past, and when the matter is brought into court the right will probably be confirmed.

August 15, 1901, the United States Mining Company filed a claim to 70 cubic feet of water per second from Jordan River, to be used as "circulating water and for the condensing plant and furnaces to be erected * * * and also for slag sluicing," at the smelter now under construction at Bingham Junction. The water is to be pumped from the river to the smelter through a 36-inch pipe line 1,400 feet long. To supply this claim there is the water from the tailraces of the Sandy Roller Mill, 23 cubic feet per second, and from the West Jordan Mill and the mattress factory when running, 41 cubic feet per second, making a total of 64 cubic feet per second, to which may be added the seepage between the North Jordan Dam and the proposed point of diversion. From this must be supplied 45.5 cubic feet per second for the Bennion Ditch. The smelter will return the water to the river above the head of this ditch, so that this right will not interfere with existing rights unless the use of the water for slag sluicing should render it injurious to vegetation. If the water becomes unfit for use in irrigation, and can not be used by the Bennion Ditch, so that that canal must be supplied from the river, there will not be water enough to fill the claims of the smelter company. This claim will also conflict with the one filed a few days previous by the North Jordan Irrigation Company, and it is not likely that this right will be allowed to become established until every legal means of preventing it has been exhausted.

May 14, 1902, South Jordan Milling Company filed notice appropriating 30 cubic feet per second in addition to 23 cubic feet per second already owned and used by it, to be used for power purposes, the water to be carried by the Beckstead Irrigation Ditch. The use of this water by the South Jordan Mill will not interfere with any other use, as the water is returned to the river above all ditches heading below the Beckstead Ditch.

The Utah Mattress and Manufacturing Company, for $6,500, conveyed to Salt Lake City all the rights of the Utah Mattress Factory to the waters of Utah Lake and Jordan River which were on the 15th day of July, 1901, decreed to it by the court, which was 11 cubic feet per second delivered at penstock of the company.

This transfer was conditioned upon the transfer being allowed by the court. The water commissioner has so far refused to recognize the transfer.

September 23, 1902, Cyrus H. Gold and Lewis T. Cannon claimed 200 cubic feet per second of the unappropriated water of Jordan River at or near its intersection with Tenth South street, Salt Lake City, 36 cubic feet per second to be used for irrigating about 2,000 acres of land lying on both sides of the river, and for the purpose of maintaining fish and duck ponds, to be diverted by means of pumps. The remaining 164 cubic feet per second to be used for power, for pumping the 36 cubic feet per second, by means of a dam which will raise the water 3½ feet higher than at present, said water to be permitted to run through notches and drive undershot wheels. This is below all existing canals, and if the water is in the river its use will not interfere with existing rights.

The Utah and Salt Lake Canal Company has purchased the right of the Sandy Roller Mill from William Cooper, but this transfer has been resisted on the ground that the mill used seepage water, and taking a like volume of water from the river at the head of the upper canal would injure the rights of others.

## RIGHTS TO THE USE OF UTAH LAKE AS A RESERVOIR.

As Utah Lake is the sole source of water for Jordan River, the use of that river for irrigation has inevitably brought up the question of storing water in the lake. The law incorporating the Deseret Irrigation Company, passed in 1867, authorized that company to construct dams in the river to hold the water of Utah Lake at any height that a majority of the selectmen of Great Salt Lake and Utah counties might agree upon. From that time to the present it has been held by all concerned that the height to which the water may be raised is a matter of agreement. The first dam in Jordan River for the purpose of holding back the water of the lake was built by Salt Lake County in 1872. The next spring water was high in the lake, and the county court of Utah County at once communicated with the county court of Salt Lake County, suggesting that the members of the courts of the two counties meet and consider what should be done in the matter. No agreement was reached, and as a consequence "the head gates washed out, being helped by persons unknown," as the record of the county court of Salt Lake County expressed it. This was in the winter of 1873–74. The dam was rebuilt the following spring. In the meantime the people of Utah County continued to complain of high water, claiming that it was caused by the dam in the river, while the county court of Salt Lake County proceeded to investigate the effect of the dam on the level of the lake. Their investigation proved to the satisfaction of those making it that the dam had no effect on the lake.[a]

In the fall of 1876 the people of Utah County made an investigation of their own, and found that the dam had raised the water in the lake 5 feet. These results were reported to the Salt Lake County court, and it in turn ordered a new investigation. This investigation is summed up as follows by the court:

> The rise of the water occasioned by said dam has been carefully ascertained by scientific and actual tests, and it does truly appear that the dam erected and as it now is does not raise the water any at the outlet of Utah Lake.[b]

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[a] Record of County Court, Salt Lake County, Book C, pp. 38–40.

[b] Ibid., p. 312.

Notwithstanding this diversity of opinion an agreement was entered into to remove so much of the dam as would permit the waters of the Jordan to flow naturally at the Indian Ford Riffle, above the dam.[a] This agreement seems to have been lived up to until 1880, when the county court of Salt Lake County appointed a committee to "ascertain by actual measurement how much higher, if any, the water in said lake can be raised without material injury to the owners of land along the shores of said lake."[b] This committee made its investigation, and reported that to hold the water at the height reached in June, 1880, 3 feet below the high-water mark of 1862, would materially injure but few, if any, of the owners of the land along the lake.[c] The dam was accordingly raised, and this action aroused renewed protests from Utah County. A mass meeting was held in Provo June 25, 1881, when the following resolution was adopted:

*Be it resolved*, That we decline to refer the matters in dispute to the arbitrament of the county courts of Utah and Salt Lake counties, but insist upon the compliance on the part of Salt Lake County, or whoever may be interested in the Jordan Dam, with the agreement to restore the riffle at the Indian Ford to its natural condition, and that in the event that the parties controlling said dam fail to commence to remove the obstructions in the Jordan in compliance with said agreement by the 15th day of July, 1881, and to prosecute said labor in good faith, that we proceed ourselves to remove so much of the dam as will be a substantial enforcement of said agreement.

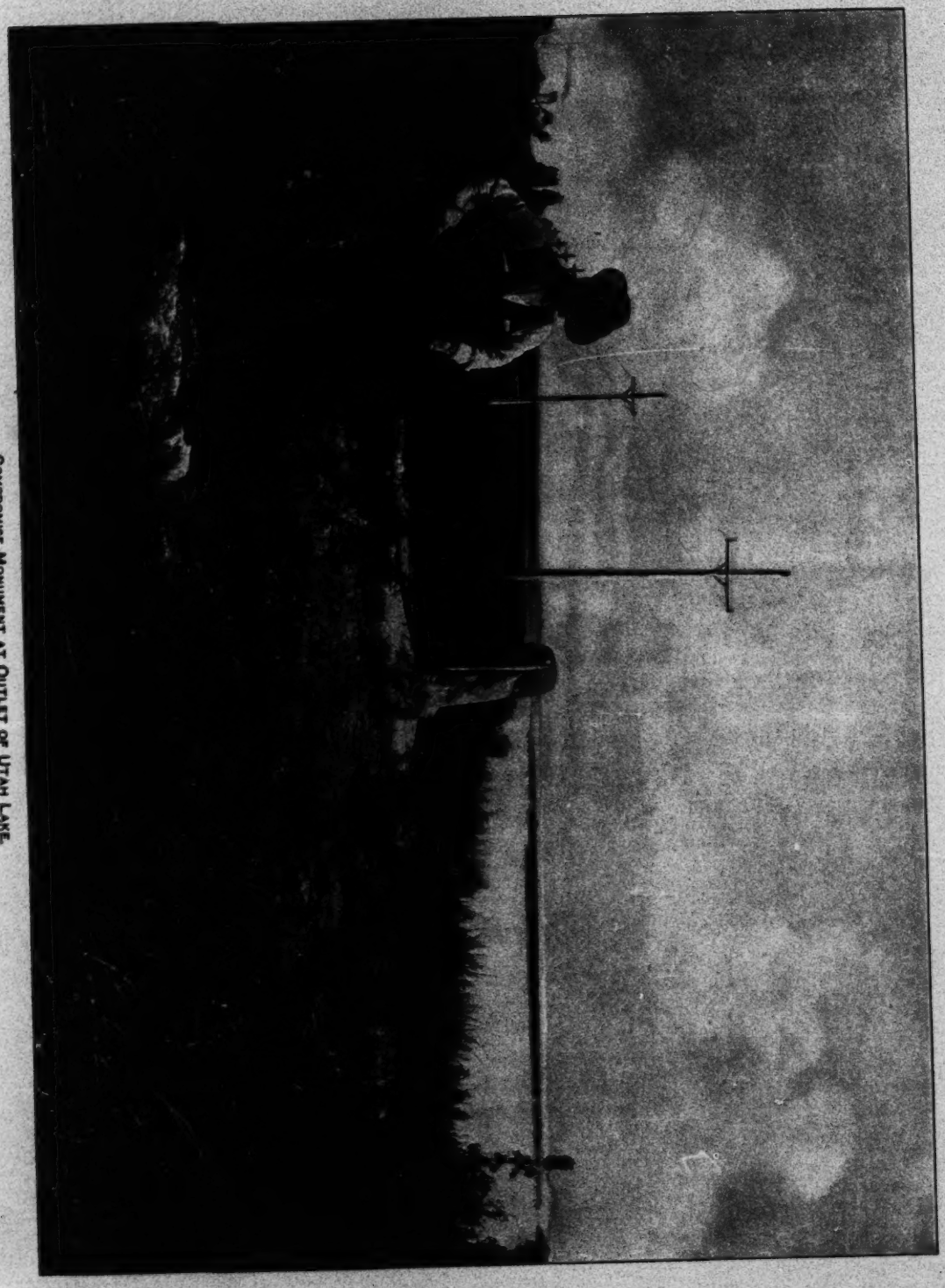
The press reports of the meeting stated that an assessment was levied on those claiming to be damaged, of 1 per cent of the damage claimed, to fight the case.[a]

In the spring of 1882, Utah County again employed an agent to investigate the effect of the dam. The agent reported that the dam set the water back only so far as the Indian Ford. In 1884, the whole subject was referred to an arbitration committee of prominent citizens, who took testimony and proposed a compromise agreement, which was adopted and is still in force. The parties to the agreement are, on the one side, the owners of land bordering the lake, and on the other side Salt Lake County, Salt Lake City, the Utah and Salt Lake, the South Jordan, the North Jordan, and the East Jordan canal companies.

This agreement provided that the water of Utah Lake might be held at a height "not to exceed 3 feet and 3½ inches above the point heretofore established and recognized as low-water mark." It also provided for a board of five persons to carry out the agreement and decide when obstructions should be placed in the river or be removed, in order that the water might not rise higher than "compromise point," and also for the dredging of the river so that the lake could be drawn down to a lower level than was possible under existing conditions.

The commissioners provided for in this agreement were appointed and proceeded to erect a monument to mark the level at which the water might be held without liability for damage. (Pl. IV.) This level has since been know as "compromise level." In 1888, 1889, and 1890, the city and canal companies carried out the plan of dredging suggested in the agreement. The river was dredged from the outlet of the lake to a point about a mile above the old dam. At this point a new dam was built to

[a] Record of County Court, Salt Lake County, Book C, pp. 848, 849.
[b] Ibid., p. 751.
[c] Ibid., p. 784.



COMPROMISE MONUMENT AT OUTLET OF UTAH LAKE.

LIBRARY
OF THE
NIVERSITY of ILLINO

TWO 20-FOOT WEIRS IN JORDAN RIVER AT NARROWS.

LIBRARY
OF THE
VERSITY of ILLINO

control the outflow from the lake. It is a timber structure, with uprights between which planks are inserted when it is desired to hold up the water. (See Pl. III, p. 40.) The dredging enables the companies to draw off the water of the lake some 14 inches lower than it could be drawn before, adding in this way 14 inches in depth over the entire lake to the available water which they can hold in the lake before it is necessary to open the waterway to dispose of flood water. Having done this dredging, the companies claimed the right to maintain planks in the new dam to the same extent that they had lowered the bed of the river, regardless of the compromise agreement and regardless of the action of the Utah Lake commission. This right was denied by the Utah County parties, and differences also arose as to the "low-water mark" referred to in the compromise agreement, and as to the right of the companies or the commission to place planks in the dam between October 15 and March 15. These matters were adjudicated in the case of Salt Lake City v. Colladge (13 Utah, p. 522). The court held in that case that the canal companies had the right to maintain 22 inches of planks in the new dam at all seasons of the year without any action of the Utah Lake commission; that the commission might place planks in the dam above this 22 inches between October 15 and March 15; and established compromise level, or the height to which water might be raised, as "4 feet, 6 inches below the top of the stone monument at the outlet of the lake, which was established by the Utah Lake commission in 1885."

This compromise agreement, as interpreted by the court in the above case, is still in force, and was recognized in the recent adjudication of rights to Jordan River, where the court held:

> That, subject to these limitations (expressed in the preceding part of the decision) and to the limitations contained in the agreement of compromise entered into in 1885 between Joseph H. Colladge and others and said city and canal and irrigation companies, the said city and canal and irrigation companies have the right at all times to shut off, impound, and store the entire flow of the Jordan River and hold and save the same for future use to the extent which, in their judgment, their interests may require.

January 18, 1900, Salt Lake City filed a claim to water from Jordan River and from Utah Lake and its tributaries. The plan, as outlined in the notice filed, is to raise the impounding dam so as to hold water in the lake 5 feet above compromise level. To do this it will be necessary to secure title to the land which will be flooded by the proposed reservoir. The city has taken the first steps toward this by having a survey made on a line 5 feet above compromise level, to find out just what lands will be flooded. The survey was made in 1900, and nothing has since been done in the matter. The capacity of the proposed reservoir above compromise level is given as 520,000 acre-feet, and the city claimed the right to draw this water off at the rate of 300 cubic feet per second. The law of 1897, which requires the posting of these notices, prescribes that construction shall begin within forty days, and the claimant must prosecute the work "with reasonable diligence to completion." The question as to whether Salt Lake City is fulfilling the requirements of this law in such a way as to establish a right is a question of fact which can be decided only by the courts.

January 30, 1900, the city filed a further notice claiming the water in Utah Lake 1½ feet below low-water mark. The quantity of water claimed is 150,000 acre-feet. To make this water available the river is to be straightened and dredged. The

survey for this new channel has been made, and a small amount of excavating has been done at the outlet of the lake, but the work has been stopped for the present.

The next day after the city filed the notice just referred to, the Salt Lake City Water and Electrical Power Company filed notice claiming the water of the lake for 2.46 feet below low-water mark. No work has been done by this company, and this claim has undoubtedly lapsed.

During the summer of 1901, which was a very dry season, there was a good deal of agitation of the question of an increased water supply. The schemes proposed include one for raising the water in Utah Lake above compromise level and one for pumping the water from the lake below the level to which it can at present be drawn off.

June 4, 1902, George C. Lambert, jr., claimed all unappropriated waters of Utah Lake and of the waters flowing therein and therefrom—1,000 cubic feet per second for power and domestic purposes and for irrigation of land situated in Salt Lake, Tooele, and Davis counties, to the amount of 20,000 acres; said water to be diverted by means of pumps situated near the outlet of Utah Lake. Rights acquired by this notice were later deeded to the Utah and Salt Lake, the East Jordan, and the South Jordan companies, which built the pumping plant proposed the year previous. To avoid any possible conflict with the rights which might have been acquired by the city by posting the notice referred to, the companies named purchased an interest in those rights in addition to posting a new notice. The pumping plant was in operation during the latter part of the season of 1902, so that the right claimed by the companies building it has undoubtedly been perfected.

## ENFORCEMENT OF WATER RIGHTS.

Until the passage of the irrigation law of 1901 there had been no recognized system of water distribution in Utah. As has been stated, the county court appointed water masters for some of the smaller streams of Salt Lake County, but no provision for the division of the water of Jordan River was ever made by that body. Up to 1880–1883, when the large canals were completed, there was no necessity for any such division, as there was more water in the river at all seasons than the canals constructed could carry. Since the completion of the large canals the practice has been for all to take all the water wanted so long as they could get it. As water became scarcer the superintendents of the large canals would go together and adjust the gates of their canals so as to divide the water equally among them, leaving as much in the river as they felt they had to. When water became still scarcer the same action would be repeated, or an engineer would be employed by them to watch the river and change the gates as was necessary to divide the water as he judged best. This system was followed out from year to year, the friction and the consequent meetings of the representatives of the companies varying with the water supply in Utah Lake.

The law of 1901 provided for the appointment of water commissioners for the various streams of the State, by the county commissioners. When the district court defined the rights on Jordan River in June, 1901, the court appointed a commissioner to enforce the decree. Later the county commissioners appointed the same man, and since the last week in June, 1901, the water of Jordan River has been divided by the commissioner, who has an assistant who spends his entire time during

the irrigation season reading the gauges on the canals in the Narrows and regulating the gates to keep the flow of the canals even. The decree of the court provides that the city and canal and irrigation companies shall at all seasons of the year allow to flow down the river a volume of water "which, when added to the accretions to the river from seepage and other sources, will furnish at the various points of diversion and measurement" the quantities awarded to the West Jordan Milling and Mercantile Company, the Utah Mattress and Manufacturing Company, the United States Mining Company, William Cooper, and Bennion & Bennion for the operation of their several mills and factories. These quantities are as follows:

*Volume of water which must be allowed to flow down Jordan River during all seasons of the year.*

| | Cu. ft. per sec. |
|---|---|
| West Jordan Mill | 30 |
| Utah Mattress Factory | 11 |
| United States Mining Company | 17 |
| William Cooper | 23 |
| Bennion & Bennion | 40 |
| Total | 121 |

The water from the tail races of the West Jordan Mill, the mattress factory, and the Cooper Mill comes into the river above the head of the mill race of Bennion & Bennion. As a consequence that right can be left out of account, leaving 81 cubic feet per second, which is necessary to fill these rights. During the irrigation season an additional quantity, as shown in the following table, must be allowed to flow down the river:

*Volume of water which must be allowed to flow down Jordan River during irrigation season.*

| | Cu. ft. per sec. |
|---|---|
| Gardner Mill Race | 5.50 |
| Galena Canal | 5.065 |
| Beckstead Ditch | 12.00 |
| Bennion Mill Race | 5.00 |
| Mousley Ditch | 2.00 |
| Cooper Ditch | 2.90 |
| Total | 32.465 |

Here again the Bennion Mill Race can be left out of account for the same reason as before, reducing the quantity to 27.465 cubic feet per second. The quantity which must be left in the river for the canals heading below the Narrows, except the North Jordan Canal, during the irrigating season is, then, 108.465 cubic feet per second. From this is to be subtracted the gain in the flow of the river from seepage. This varies from 40 to 60 cubic feet per second,[a] leaving some 60 cubic feet per second which must be supplied from above the dams, during the irrigating season, and 35 cubic feet per second during the remainder of the year.

Measuring stations have been established in the canals in the Narrows and also in the river below the power plant. The practice of the water commissioner is to

[a] See table, page 82.

measure all the canals and the river below the power plant, obtaining in this way the quantity of water supplied by the river. To this is added the quantity which his measurements have shown him is coming into the river from seepage at the time. From this sum is subtracted the quantity which must be supplied to the canals below, with the exception of the North Jordan. The remainder divided by 5 gives the quantity which should be awarded to each of the five large canals. Having determined in this way how much water each of the canals should be carrying, the commissioner or his deputy regulates the gates. The table which follows shows the average flow of the river for each month during the season of 1901, since the appointment of the water commissioner and the apportionment of the water to the five canals having equal rights to the water:

*Record of apportionments of Jordan River water, 1901.*

| Date. | Flow of river. | Seepage. | Apportionment to each canal. | Apportionment waste water to each canal. | Total to each canal. |
|---|---|---|---|---|---|
| 1901. | *Cubic feet per second.* | *Cubic feet per second.* | *Cubic feet per second.* | *Cubic feet per second.* | *Cubic feet per second.* |
| June[a] | 209.96 | 60.00 | 32.34 | ..... | 32.34 |
| July | 198.19 | 41.43 | 23.98 | 3.05 | 27.93 |
| August | 134.24 | 41.94 | 14.12 | 6.28 | 20.40 |
| September | 92.414 | 34.57 | 3.488 | 7.24 | 10.488 |

[a] Only one measurement made.

The first division of the water is made at the "old dam," which is at the head of the Utah and Salt Lake and East Jordan canals. The East Jordan Canal is given its portion of the water at this point; the city's water is left in the river, where there are weirs for its measurement (Pl. V), and all the remainder is taken into the Utah and Salt Lake Canal. The city diverts its water into its canal about a mile below the old dam, where it has a tight dam in the river. The Utah and Salt Lake Canal flows into a fore bay just above the power plant, about 2 miles below the head. Here the Utah and Salt Lake Canal is given its portion of the water, and what is left flows into the pipes of the power plant. After dropping 40 feet to the turbines, part of the water is discharged into South Jordan Canal and the remainder into the river. The water discharged into the river is to supply the rights enumerated in the decree and also the North Jordan Canal. The Mousley, Galena, Beckstead, and Cooper ditches divert their water between the power plant and the dam of the North Jordan Canal. None of these canals can carry much more water than is decreed to them, so the commissioner pays little attention to them. All the water in the river is taken into the North Jordan Canal at its dam. This supplies the farmers under the Gardner Mill Race, the West Jordan Mill, the Utah Mattress Factory, and the North Jordan Canal. These rights amount to 46.5 cubic feet per second, in addition to the share of the river belonging to the North Jordan Canal. The mattress factory and the mill seldom run nights and Sundays, and the question has arisen as to whether the water to which they have a right should be divided during these times among the five canals having equal rights to the river or should all go to the North Jordan Canal. This latter company claims to have had the use of this water for twenty years past,

and August 9, 1901, filed a notice claiming it, and the water commissioner, under the direction of the court, allowed this company the use of this water during the season of 1901. The commissioner pays no attention to the Bennion Ditch, as there is always plenty of water at its head. If the United States Mining Company carries out its plans mentioned before, it may be necessary for the commissioner to protect the Bennion Ditch in its rights.

Another question which is very likely to arise relates to the rights of the power company. The decree gives that company the right to make an intermediate use of the water belonging to the canals heading below its tailrace. These canals do not always take their full supply. The question arises, Can the power company demand that the full quantity decreed to these canals be turned down the river, whether or not the mills entitled to its use want the water? It has several times been proposed that the canal companies buy out these mill rights, as the water is much more valuable for irrigation than for power. During the summer of 1902 the rights of the mattress company and of the Cooper Mill have been purchased by the canals heading in the Narrows, and the transfer of the water has been resisted by the owners of the power plant and others whose ditches head below the power plant. The transfers are still pending, but so far have not been made.

To sum up the water-right situation on the Jordan and Utah Lake: Early in the season of 1901 the court defined all rights to the river and lake and appointed a commissioner to enforce them, the court retaining jurisdiction to make any modifications of the decree which might be necessary. Since the rendering of this decree several new claims have been filed, each of which, if carried out, will require further rulings by the court, while the transfers just referred to raise questions which can be decided only by reference to the court.

## THE ORGANIZATION OF CANAL COMPANIES AND OPERATION OF CANALS.

The organization of the Jordan River canal companies is the same throughout. They are stock companies organized under the general incorporation laws of the State. Each share of stock in a company entitles its holder to one vote in all the affairs of the company and to a share of the water furnished by the canal, all the water in the canal being divided among the stockholders in proportion to the number of shares held by each. All expenses are met by annual assessments on the stock of the company, and since there is no other income, the only dividend is water. Both subscriptions to stock and annual assessments are largely paid in work, but not entirely. Some money is necessary in the construction and operation of canals and a part of subscriptions and assessments must, therefore, be paid in money. Stock is sold the same as stock in any other corporation, and the water representing the dividends on stock may be used on any land which can be reached by the canal. Stockholders who own no land or who, for any reason, do not wish to use the water to which they are entitled may rent their stock and the water may be used by the renter. This plan of organization makes water personal property and makes monopoly possible, since the stock may be bought up by a few persons. So far there has been no such tendency in the Utah companies. Statements on this point have been secured from the secretaries of three of these companies. The East Jordan Canal

Company has one shareholder for each 6¼ acres of land watered, the South Jordan Canal Company has one shareholder to each 13.85 acres, and the North Jordan Irrigation Company has a shareholder for each 26.14 acres. These companies have been organized in their present form for more than twenty years, giving plenty of time for centralizing tendencies to have worked out if they exist, but, notwithstanding this possibility, stock continues to be owned chiefly by the landowners, who use the water themselves.

Each canal company has a superintendent, elected by the stockholders. The duties of the superintendent are to direct the work of keeping his canal in order and to distribute the water to those entitled to it. Water is distributed to farmers in proportion to the number of shares controlled by each, and, as a rule, several shareholders draw their water from the canal through one lateral, so that the diversion at each gate in a canal usually represents several hundred shares of stock.

The water is measured to the stockholder over a weir placed in the lateral a short distance below the canal. Water is turned through a gate in the canal bank until the proper depth on the weir is obtained, when the gate is locked in that position, and the key is kept by the superintendent.

The whole distribution is based on the flow of the water over the weirs, and its fairness depends as much on the proper construction and setting of the weirs as on the operation of the gates in the canal. This fact does not seem to have received as much attention as it should. Some weirs are set high, so that there is no velocity of approach; others are set low, and the water approaches them with velocities varying from a few inches to several feet per second. This is the greatest source of error in the division of water. Another cause of difference is the variation in the end contractions. Some of the weirs are as wide as the channel above them, and one examined was wider, as there was a post just above the weir jutting out into the channel four or five inches. Others are narrower than the channel. The system as it is is a great advance over the old way of guessing as to the size of the streams turned into the laterals, but the conditions mentioned need attention. With these conditions made uniform and careful attention paid to the gates to maintain proper depths on all the weirs, the system would be all that could be desired.

When the water is turned into the laterals it passes from the control of the canal company. The shareholders under a lateral control that stream just as the company controls the water in the canal. All the water in the lateral is used by the farmers under it in turn, the time for which each has the use of the stream being determined by the number of shares which he controls. The water users decide how often each shall have the water—once in 8½ days is a common interval—then divide the number of minutes in this period by the number of shares represented in their stream. This gives the length of time each share entitles its holder to use the stream during the period of rotation. A time schedule for the season is then made out, showing at just what time each person shall begin and stop using the water. A water master is elected to see that this schedule is enforced, and also to see that the ditch is kept in repair. As a rule no assessments are made for this latter purpose, but the farmers turn out and do whatever work is necessary, under the direction of the water master. After the ditch has been put in condition in the spring the water master has usually very little to do, as each person goes and takes the water when his turn comes and

uses it until the one entitled to it next does the same. In this way the water is distributed without any action on the part of the water master, unless there is some disagreement, when he is called in to decide the matter in question. There is no necessary uniformity in the arrangements made under the different laterals, but the system is practically the same throughout the whole State of Utah, the only variation being in the periods of rotation and in the time allotted for each share of stock.

In times of extreme scarcity of water, when the streams allotted to the laterals become too small to be of use, a system of "doubling up" is adopted. The water belonging to two or more laterals is used in turn by the several laterals in the agreement, just as the stream in the lateral is used in turn by the farmers under it. In this way the irrigators get water less often than they otherwise would, but get a good working stream when they get any.

## THE UTAH AND SALT LAKE CANAL.

The Utah and Salt Lake Canal Company was organized as a stock company, under the general incorporation laws of the Territory of Utah, in 1880. The capital stock is $250,000, divided into 10,000 shares of $25 each. There is a board of seven trustees, the members of which serve two years. This board is empowered to adopt rules for the management of the canal, subject to the approval of a two-thirds vote of the shareholders present at any regular biennial or specially called meeting.

The system adopted on this canal for dividing the water equitably is to measure it over weirs, the length of which is proportioned to the number of shares represented in the stream to be drawn over them, so that a uniform depth on all the weirs will give a practically even flow per share over the whole canal. An attempt is made to set the gates in such a way that the distribution of the water will be automatic, the depth varying uniformly on all the weirs as the water in the canal rises or falls. This is not accomplished, however, owing to several causes, chief among which is the growth of water grass in the canal. This grass checks the flow of the water, holding it up on the gates near the head of the canal and causing them to discharge more water than they should, and leaving less in the canal than should go to the lower laterals. This makes it necessary for the superintendent to spend a good deal of time in regulating the gates. It also causes considerable dissatisfaction among those taking water from the upper part of the canal, as it is necessary for the superintendent to close their gates as the water rises, while they think their gates should be set in the spring and remain the same all summer. As the supply of water in the canal varies from day to day with the flow of the river, it is necessary for the superintendent to keep a constant watch on his gates, and even then the distribution can be only approximately correct.

Measurements of the discharge of the canal were carried on during the season of 1900 by the city engineer of Salt Lake City, and during 1901 by the water commissioner. Both of these officials have kindly allowed the use of their measurements for this report. The average monthly flow of the canal for 1900 is given below. Water was used during April before any measurements were made, so that the table does not show the quantity of water furnished by the canal during the season. The flow for most of August and September is estimated, the estimates

being the averages of the flow of the other three canals heading in the Narrows for the same days. The effort is made to allow to these four canals equal volumes of water, and there is no great error in assuming that the discharge of any one is equal to the average of the other three. No estimates are made for days when less than three measurements are at hand. No close measurement of the area irrigated has been made. The area given in the decree of the court is 16,000 acres. A number of those interested in the canal stated that the farmers under this canal usually controlled about 1½ shares of stock for each acre irrigated. As there are but 10,000 shares of stock, the area irrigated, estimated on this basis, is 6,666 acres, approximately 7,000 acres. This latter estimate is probably the most nearly correct, as the supply of water is too small, even for this area, and would be wholly inadequate for 16,000 acres.

The following table gives the duty of water under this canal, on the basis of both these estimates:

*Duty of water under Utah and Salt Lake Canal, 1900.*

| Month. | Discharge. | | Area. | Area per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Acre-feet.* | *Acres.* | *Acres.* | *Feet.* |
| May | 81.6 | 5,017.39 | 16,000 | 196.1 | 0.31 |
| | | | 7,000 | 85.8 | .72 |
| June | 78.6 | 4,524.62 | 16,000 | 203.9 | .28 |
| | | | 7,000 | 91.4 | .64 |
| July | 42.3 | 2,600.98 | 16,000 | 378.3 | .16 |
| | | | 7,000 | 165.5 | .37 |
| August | 27.9 | 1,715.50 | 16,000 | 573.5 | .11 |
| | | | 7,000 | 250.9 | .25 |
| September (27 days) | 19.2 | 1,035.28 | 16,000 | 833.3 | .06 |
| | | | 7,000 | 364.6 | .15 |
| Total | 50.15 | 14,929.07 | 16,000 | 319.04 | .92 |
| | | | 7,000 | 148.6 | 2.11 |

As shown by the table, the discharge of the canal from May 1 to September 27 would cover 16,000 acres to a depth of 0.92 foot, and 7,000 acres to a depth of 2.11 feet. The loss from this canal from seepage is at least one-fourth of the flow at the point where the measurements were made, which would reduce the above depths to 0.69 and 1.58 feet, or 8.29 and 18.19 inches, respectively.

Since the measurements for 1901 begin with July, no general statement of the duty of water for the season can be made. It will be interesting, however, to compute the duty for the part of the season during which measurements were made for comparison with the same period in 1900.

*Duty of water under Utah and Salt Lake Canal, 1901.*

| Month. | Discharge. | | Area. | Area per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | Cu. ft. per sec. | Acre-feet. | Acres. | Acres. | Feet. |
| July | 30.07 | 1,848.96 | 16,000 | 532.1 | 0.12 |
| | | | 7,000 | 232.8 | .26 |
| August | 20.13 | 1,237.13 | 16,000 | 795.4 | .08 |
| | | | 7,000 | 347.9 | .18 |
| September | 10.97 | 652.76 | 16,000 | 1,458.5 | .04 |
| | | | 7,000 | 638.1 | .09 |
| October (17 days) | 6.74 | 227.46 | 16,000 | 2,373.8 | .01 |
| | | | 7,000 | 1,038.5 | .06 |
| Total | 18.34 | 3,966.35 | 16,000 | 872.4 | .23 |
| | | | 7,000 | 381.6 | .57 |

It will be noticed that the water supply was considerably shorter in 1901 than in 1900.

The duty of water assumed by the court in defining the rights of the small canals on the Jordan River was 50 acres per cubic foot per second. On this basis the average flow of the Utah and Salt Lake Canal during the season of 1900 would have irrigated 2,508 acres, and the average flow from July 1 to October 17, 1901, would have irrigated but 917 acres.

The cost of water to the farmers under the Utah and Salt Lake Canal is the cost of operating the canal and defending their rights in the courts, since they own the canal. These expenses are met by annual assessments on the stock of the company, the assessments for each of the past five years being 50 cents per share of stock. A large part of the assessment for maintaining the canal is worked out, but the wages of the superintendent and the legal expenses must be paid in cash. To this must be added the pay of the water masters, which on some laterals is 10 cents per share. Assuming that this is the average for the whole canal, the total outlay per share of stock is 60 cents per year and the total expense of maintaining and operating the canal and laterals and protecting its rights is $6,000 per year. On the basis of 1¼ shares to the acre irrigated, farmers under this canal pay 90 cents per acre for water. Shares sell for from $16 to $20.

### THE EAST JORDAN CANAL.

This company was incorporated in 1878, being the first of the Jordan River canal companies to organize under the general incorporation law. The capital stock is $200,000, in shares of $25 each; but not all the stock has been issued, 7,250 shares having been sold to January, 1902. The articles of incorporation provided that payments for stock need not necessarily be made in money, but may be paid in "labor or materials actually employed in the construction and maintenance of said canal, or in the management or direction thereof." A board of eleven directors elected biennially controls the affairs of the company.

The system of operation under this canal is in general the same as that of the Utah and Salt Lake Canal. The water is measured to the laterals over a portable

Cippoletti weir. The superintendent computes the quantities which should be allowed to each lateral, then goes over the canal placing the portable weir in each lateral, and regulating the gate until the proper volume is flowing over the weir, when the gate is fastened. As the condition of the canal changes it is necessary to change the gates. The same trouble from water grass that is experienced by the other canals exists here, making it necessary to close the upper gates, which creates dissatisfaction along that part of the canal.

The average monthly flow of the canal for the seasons of 1900 and 1901, computed in the same way as the flow of the Utah and Salt Lake Canal above, is given in the following tables:

The area watered by this canal as given by the court is 16,000 acres, but several agreed that the average water user controlled about three shares of stock to one acre cultivated. This would reduce the area to 2,417 acres. It is very probable that neither of these estimates is correct, although the latter is nearer the truth. The following table gives the duty of water for 1900 calculated on both bases.

*Duty of water under East Jordan Canal, 1900.*

| Month. | Discharge. | | Area. | Area per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Acre-feet.* | *Acres.* | *Acres.* | *Feet.* |
| May | 68.5 | 4,273.29 | 16,000 | 230.2 | 0.27 |
| | | | 2,417 | 34.8 | 1.77 |
| June | 80 | 4,046.28 | 16,000 | 235.3 | .25 |
| | | | 2,417 | 35.5 | 1.67 |
| July | 46.2 | 2,477.95 | 16,000 | 337 | .15 |
| | | | 2,417 | 50.9 | 1.02 |
| August | 27.8 | 1,673.42 | 16,000 | 566.1 | .10 |
| | | | 2,417 | 86.5 | .69 |
| September | 19 | 1,017.85 | 16,000 | 842.1 | .06 |
| | | | 2,417 | 127.2 | .42 |
| Total | 45.4 | 13,493.75 | 16,000 | 352.4 | .83 |
| | | | 2,417 | 53.2 | 5.58 |

On a basis of 16,000 acres irrigated, the table shows that each cubic foot per second average flow for the season served 352.4 acres, and would have covered that area to a depth of 0.83 foot or 10.12 inches. The same average volume of water, on the basis of 2,417 acres irrigated, served 53.2 acres per cubic foot per second, and covered it to a depth 5.58 feet. Reducing these depths by 25 per cent for loss, gives 7.59 inches and 4.19 feet, respectively.

*Duty of water under East Jordan Canal, 1901.*

| Month. | Discharge. | | Area. | Area per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Acre-feet.* | *Acres.* | *Acres.* | *Feet.* |
| July | 27.49 | 1,690.23 | 16,000 | 582 | 0.11 |
| | | | 2,417 | 87.9 | .69 |
| August | 19.76 | 1,214.90 | 16,000 | 809.7 | .08 |
| | | | 2,417 | 122.3 | .50 |
| September | 10.37 | 617.06 | 16,000 | 1,542.9 | .04 |
| | | | 2,417 | 233.1 | .25 |
| October (17 days) | 2.86 | 96.44 | 16,000 | 5,594.4 | .01 |
| | | | 2,417 | 841.6 | .04 |
| Total | 16.74 | 3,618.77 | 16,000 | 955.7 | .22 |
| | | | 2,417 | 144.4 | 1.49 |

On a duty of 50 acres per cubic foot per second the volume furnished by this canal during the season of 1900 would have served 2,275 acres, and the average from July 1 to October 17, 1901, would have served 837 acres.

The assessment on the stock of the East Jordan Irrigation Company for 1900 was 50 cents per share. Assuming that the cost of distribution on the laterals is 10 cents per share of stock, as on the Utah and Salt Lake Canal, the total cost of water is 60 cents per share, or a total of $4,350 for the canal and laterals. At three shares to the acre, water under this canal cost $1.80 per acre, but for this price the water users obtained nearly four times as much water as farmers under the Utah and Salt Lake Canal, while they paid but twice as much. Under neither of these canals was the supply of water sufficient during the season of 1900. The assessment for 1901 was but 25 cents per share, making the cost of water but half what it was in 1900. The canal furnished but little more than half as much water in the latter year, and as a consequence most crops burned up.

## THE SOUTH JORDAN CANAL.

The organization of this canal company is similar to that of the companies already described. It was incorporated in 1880 with a capital stock of $150,000, in shares of $25 each. The canal was under the control of an irrigation district organization at the time of the incorporation of the South Jordan Canal Company, and stock of the new company was issued in payment for work under the old organization. The management of this canal is similar to that of the other canals. The water is measured to the laterals over Cippoletti weirs set in convenient places near the canal.

A map of this canal belonging to the company shows the area irrigated to be 8,914.67 acres. The secretary of the company is authority for the statement that the farmers control one share of stock to three-fourths of an acre of land cultivated. As there are 6,000 shares of stock, the area cultivated, estimated on this basis, is 4,500

acres. The following table gives the duty of water for the season of 1900, on both estimates of the area irrigated:

*Duty of water under South Jordan Canal, 1900.*

| Month. | Discharge. | | Area. | Area per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Acre-feet.* | *Acres.* | *Acres.* | *Feet.* |
| May | 73.4 | 4,513.19 | 8,914.67 | 121.4 | 0.51 |
| | | | 4,500 | 61.3 | 1 |
| June | 73 | 4,343.80 | 8,914.67 | 122.6 | .49 |
| | | | 4,500 | 61.6 | .97 |
| July | 42.4 | 2,607.07 | 8,914.67 | 210.3 | .29 |
| | | | 4,500 | 106.1 | .56 |
| August | 29.5 | 1,813.88 | 8,914.67 | 302.2 | .20 |
| | | | 4,500 | 152.5 | .40 |
| September (27 days) | 19.7 | 1,055.01 | 8,914.67 | 452.5 | .12 |
| | | | 4,500 | 228.4 | .23 |
| Total | 48.2 | 14,322.95 | 8,914.67 | 185.3 | 1.61 |
| | | | 4,500 | 93.6 | 3.18 |

As shown by the table, the average flow of the canal from May 1 to September 27 was 48.2 cubic feet per second. This volume of water would cover 8,914.67 acres of land to a depth of 1.61 feet or 19.29 inches in the period of time given, and during the same time would cover 4,500 acres to a depth of 3.18 feet. Measurements on the Jordan and Salt Lake City Canal have shown that the canal gains more from inflowing seepage from above than it loses below during the early part of the season, and loses during the later months more than it gains, and it is quite probable that the same condition exists in the South Jordan Canal, as it has a strip of irrigated land above it throughout its entire length. Assuming this to be true, no reduction should be made in the above depths for loss from seepage.

*Duty of water under South Jordan Canal, 1901.*

| Month. | Discharge. | | Area. | Area per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Acre-feet.* | *Acres.* | *Acres.* | *Feet.* |
| July | 27.54 | 1,693.57 | 8,914.67 | 323.7 | 0.19 |
| | | | 4,500 | 163.4 | .38 |
| August | 19.33 | 1,189.56 | 8,914.67 | 461.2 | .13 |
| | | | 4,500 | 233.8 | .26 |
| September | 11.70 | 696.20 | 8,914.67 | 761.9 | .08 |
| | | | 4,500 | 384.6 | .15 |
| October (17 days) | 7.64 | 257.61 | 8,914.67 | 1,166.8 | .03 |
| | | | 4,500 | 589 | .06 |
| Total | 17.74 | 3,836.74 | 8,914.67 | 502.5 | .43 |
| | | | 4,500 | 253.7 | .85 |

The area which this canal would have served during the season of 1900 on a duty of 50 acres per cubic foot per second was 2,410 acres. The average flow for the part of the season of 1901 would have watered 887 acres on a like duty.

The assessment under this canal for the year 1900 was 75 cents per share, or, including 10 cents per share for the water master, a total of $5,100 for the canal. At one share for three-fourths of an acre, this would make the water under the canal cost $1.13 per acre. This is more than the average for this canal, the average for eighteen years being 89 cents per acre, according to the secretary of the company. Stock in this canal sells for from $20 to $25 per share.

## THE NORTH JORDAN CANAL.

This canal company was incorporated in 1880 with a capital stock of $100,000, in shares of $25 each. The water is measured to the laterals over Cippoletti weirs, set at convenient points. These weirs are well constructed but velocity of approach is wholly neglected in computing the discharge. As this varies greatly, it destroys the accuracy of the measurements.

But few measurements of the discharge of the North Jordan Canal have been made and those were made in the daytime. During nights and Sundays this canal takes the water belonging to the mill and mattress factory at West Jordan, so that the measurements do not in any way represent the water furnished. The water commissioner states that from July 1 to September 10, 1901, an average flow of at least 14 cubic feet per second should be added to the measured discharges for the mill water used nights and Sundays. The duty of water under this canal for the season of 1901, adding this 14 cubic feet per second, is given below. The area served by this canal is given by the court as 8,000 acres. The people under the canal claim to use "one share to the acre," which would give but 4,000 acres irrigated. The following table gives the duty of water on both estimates:

*Duty of water under North Jordan Canal, 1901.*

| Month. | Discharge. | | Area. | Area per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | Cu. ft. per sec. | Acre-feet. | Acres. | Acres. | Feet. |
| July | 40.43 | 2,486.94 | 8,000 | 197.9 | 0.31 |
| | | | 4,000 | 99 | .62 |
| August | 41.60 | 2,557.88 | 8,000 | 192.3 | .32 |
| | | | 4,000 | 96.2 | .64 |
| September | 27.45 | 1,633.39 | 8,000 | 291.4 | .20 |
| | | | 4,000 | 145.7 | .41 |
| October (17 days) | 7.88 | 265.71 | 8,000 | 1,015.2 | .04 |
| | | | 4,000 | 507.6 | .07 |
| Total | 32.11 | 6,942.92 | 8,000 | 249.1 | .87 |
| | | | 4,000 | 124.6 | 1.74 |

Unlike the other canals, this canal received more water during 1901 than in the previous year, although the river furnished a much smaller supply.

The assessments on this canal run from 40 to 75 cents per share per annum, or an average of 57.5 cents, making a total of $2,300. The superintendent of the canal is authority for the statement that 25 cents per share, or $1,000, will maintain and operate the canal itself, and that the remainder of these assessments goes for litiga-

tion. Farmers control about one share to the acre, making a cost of 57.5 cents per acre. Shares sell for from $10 to $12.

### THE BRIGHTON CANAL.

The ditch which has developed into the Brighton Canal was at first a private enterprise. It then passed into the hands of the Jordan Irrigation Company, which was chartered by the Territorial legislature. This company was followed by an irrigation district, and this, in turn, by the present company, which was organized as a stock company in 1882. The organization and management is the same as that of the other companies described.

No continued measurements of the discharge of this canal have been made. The water supply is ample, and the farmers get all they want throughout the season. The assessment for 1900 was 35 cents per share of stock. The usual practice is to use two shares of stock per acre, making the cost of water 70 cents per acre. Stock sells for $2 per share.

### SMALLER CANALS.

The smaller canals from the Jordan River are managed in the same way as the ones previously described, the streams being used in turn by those having an interest in them. As has been stated, they irrigate small areas of bottom land.

Measurements of the discharges of these canals were made at intervals during the seasons of 1900 and 1901. The average of these measurements with the area irrigated are given in the tables which follow:

*Duty of water under Mousley Ditch, 1900.*

| Month. | Discharge. | | Area. | Area per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Acre-feet.* | *Acres.* | *Acres.* | *Feet.* |
| June | 2.84 | 168.99 | a 87.5 | 30.8 | 1.93 |
| July | 2.97 | 182.62 | 87.5 | 29.5 | 2.09 |
| August | 2.39 | 141.42 | 87.5 | 38 | 1.62 |
| September | 1.50 | 89.26 | 87.5 | 58.3 | 1.02 |
| Total | 2.40 | 582.29 | 87.5 | 36.5 | 6.66 |

a Area given in decree of court.

*Duty of water under Mousley Ditch, 1901.*

| Month. | Discharge. | | Area. | Area per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Acre-feet.* | *Acres.* | *Acres.* | *Feet.* |
| July | 2.81 | 172.83 | 87.5 | 31.1 | 1.98 |
| August | 1.96 | 120.52 | 87.5 | 44.6 | 1.38 |
| September | 2.27 | 135.07 | 87.5 | 38.5 | 1.54 |
| October (17 days) | 2.20 | 74.18 | 87.5 | 39.8 | .85 |
| Total | 2.32 | 502.59 | 87.5 | 37.7 | 5.75 |

*Duty of water under Beckstead Ditch, 1900.*

| Month. | Discharge. | | Area. | Area per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | Cu. ft. per sec. | Acre-feet. | Acres. | Acres. | Feet. |
| June | 17.02 | 1,012.76 | a 580 | 31.1 | 1.91 |
| July | 13.09 | 804.87 | 580 | 40.5 | 1.62 |
| August | 8.76 | 534.94 | 580 | 60.9 | 1.01 |
| September | 4.75 | 282.64 | 580 | 111.6 | .58 |
| Total | 10.89 | 2,635.21 | 580 | 48.7 | 4.97 |

a Area given in decree of court.

*Duty of water under Beckstead Ditch, 1901.*

| Month. | Discharge. | | Area. | Area per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | Cu. ft. per sec. | Acre-feet. | Acres. | Acres. | Feet. |
| July | 13.96 | 821.47 | 580 | 39.7 | 1.[illegible] |
| August | 4.75 | 292.07 | 580 | 111.6 | .56 |
| September | 6.86 | 388.36 | 580 | 77.8 | .73 |
| Total | 8.32 | 1,501.90 | 580 | 69.7 | 2.83 |

*Duty of water under Galena Canal, 1900.*

| Month. | Discharge. | | Area. | Area per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | Cu. ft. per sec. | Acre-feet. | Acres. | Acres. | Feet. |
| June | 7.70 | 458.13 | a 322 | 41.8 | 1.42 |
| July | 7.99 | 472.64 | 322 | 41.9 | 1.47 |
| August | 5.20 | 323.85 | 322 | 60.8 | 1.01 |
| September | 5 | 297.52 | 322 | 64.4 | .91 |
| Total | 6.42 | 1,554.42 | 322 | 50.2 | 4.81 |

a Area given in decree of court.

*Duty of water under Galena Canal, 1901.*

| Month. | Discharge. | | Area. | Area per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | Cu. ft. per sec. | Acre-feet. | Acres. | Acres. | Feet. |
| July | 9.77 | 600.73 | 322 | 33 | 1.87 |
| August | 7.33 | 463 | 322 | 43.8 | 1.44 |
| September | 4.66 | 285.56 | 322 | 71.9 | .89 |
| Total | 7.19 | 1,360.31 | 322 | 44.8 | 4.14 |

## COMPARATIVE STATEMENTS.

### DUTY OF WATER.

The following table brings together the measurements on all the canals, and the statements as to the area irrigated and the depth of water received by the land:

*Duty of water under Jordan River canals.*

| Name. | Discharge. | | Area. | Area per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| 1900. | *Cu. ft. per sec.* | *Acre-feet.* | *Acres.* | *Acres.* | *Feet.* |
| Utah and Salt Lake Canal | 59.15 | 14,780.07 | 16,000 | 319.04 | 0.92 |
| | | | 7,000 | 140.82 | 2.11 |
| East Jordan Canal | 45.40 | 13,496.75 | 16,000 | 352.40 | .83 |
| | | | 2,417 | 53.24 | 5.58 |
| South Jordan Canal | 48.20 | 14,322.95 | 8,914.67 | 185.30 | 1.61 |
| | | | 4,000 | 96.60 | 3.18 |
| Jordan and Salt Lake City Canal | 39.70 | | | | |
| Mousley Ditch | 2.41 | 582.29 | 87.50 | 36.30 | 6.66 |
| Beckstead Ditch | 10.80 | 2,483.21 | 580 | 48.70 | 4.97 |
| Galena Canal | 6.42 | 1,554.42 | 322 | 50.20 | 4.81 |
| 1901. | | | | | |
| Utah and Salt Lake Canal, July 1 to October 17 | 18.84 | 3,966.28 | 16,000 | 872.4 | .25 |
| | | | 7,000 | 381.6 | .57 |
| East Jordan Canal, July 1 to October 17 | 16.74 | 3,618.77 | 16,000 | 955.7 | .23 |
| | | | 2,417 | 144.4 | 1.49 |
| South Jordan Canal, July 1 to October 17 | 17.74 | 3,825.74 | 8,914.67 | 502.5 | .43 |
| | | | 4,500 | 253.7 | .85 |
| Jordan and Salt Lake City Canal, July 1 to October 15 | 19.11 | | | | |
| Mousley Ditch, July 1 to September 30 | 2.32 | 502.59 | 87.50 | 37.7 | 5.75 |
| Beckstead Ditch, July 1 to September 30 | 8.33 | 1,801.90 | 580 | 69.7 | 2.83 |
| Galena Canal, July 1 to September 30 | 7.29 | 1,320.31 | 322 | 44.2 | 4.14 |

Too much weight should not be given to the above statement regarding the large canals because of the uncertainty as to the area irrigated. Taking the smaller estimates as to this area, lands under the Utah and Salt Lake Canal received the smallest supply of water, those under the South Jordan Canal the next smallest, and those under the East Jordan Canal the largest supply of any of the canals named. As was stated before, 2,417 acres is probably too low an estimate of the area covered by the last-named canal. The depths furnished to the lands under the small canals are greater than would seem to be necessary, and in the cases of the Mousley and Galena ditches, the average discharges for the season given in the table are greater than the volumes decreed these canals by the court. The average discharge of the Beckstead Ditch is not so great as the volume decreed to that canal. However, the volumes of water used by these small canals make little difference to those having later rights, as the water is used on the bottom lands immediately adjoining the river, and any excessive quantities will find their way into the river in a very short time, and help to make up the volume required to supply the North Jordan Canal.

### COST OF WATER.

No statements as to the expense of maintaining the small canals were obtained. The cost of a water supply under the large canals is summarized below:

*Cost of water under Jordan River canals, 1900.*[a]

| Name of canal. | Number of shares. | Assessment per share. | Total cost. | Cost per acre. | Cost per acre-foot. | Cost per cubic foot per second. |
|---|---|---|---|---|---|---|
| Utah and Salt Lake Canal | 10,000 | $0.50 | $5,000 | $0.75 | $0.94 | $101.01 |
| East Jordan Canal | 7,250 | .50 | 3,625 | 1.50 | .22 | 66.66 |
| South Jordan Canal | 6,000 | .75 | 4,500 | 1.00 | .31 | 92.56 |
| North Jordan Canal | 4,000 | .575 | 2,300 | .575 | ..... | ..... |
| Brighton Canal | ..... | .35 | ..... | .70 | ..... | ..... |

[a] Not including pay of water masters on laterals, which varies.

### SEEPAGE MEASUREMENTS.

The court decreed that the canal companies which were given equal rights in the river were to allow to pass down the river a volume of water which, when added to the accretions to the flow of the river from seepage, would supply the canals heading below. This action was anticipated by the city engineer of Salt Lake City, and during the season of 1900 and part of the season of 1901 he had measurements made to determine the increase in the flow of the river from seepage. The section of the river included in the measurements lies between the power plant and the head of the North Jordan Canal, and is about 10 miles long. The only visible addition to the stream in this section is the tailrace of the South Jordan Mill. Diversions are made by the Mousley, Galena, Beckstead, and Cooper ditches. The river is measured just below the tailrace of the power plant. To the discharge at this point is added the discharge of the tailrace of the South Jordan Mill. This gives the total visible supply of water. To the sum of the diversions made by the canals heading above the North Jordan Dam is added the discharge of the North Jordan Canal and the quantity which leaks through the dam. This sum should check with the supply if there was no gain or loss from sources which could not be measured.

The following tables give the measurements made and the gain in the flow of the river:

*Gain in flow of Jordan River between power plant and head of North Jordan Canal.*

[Distance: Approximately 10 miles. Measurements made for city engineer, Salt Lake City.]

| Date. | Inflow. | | | Outflow. | | | | | | | Gain. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | River below power plant. | Tailrace South Jordan Mill. | Total. | Mousley Ditch. | Beckstead Ditch. | Galena Ditch. | Cooper Mill Ditch. | North Jordan Canal at head. | River below North Jordan Canal. | Total. | |
| | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* |
| June 11, 1900 | 62.0 | 18.3 | 80.3 | 3.0 | 32.8 | 0.0 | 0.0 | 98.4 | 3.5 | 137.7 | 57.4 |
| June 18, 1900 | 63.7 | 15.8 | 79.5 | 3.0 | 31.5 | 7.2 | 28.8 | 70.2 | 3.0 | 143.7 | 64.2 |
| June 22, 1900 | 56.2 | 17.2 | 73.4 | 2.6 | 28.9 | 9.1 | 29.2 | 0.0 | 68.2 | 138.0 | 64.6 |
| July 5, 1900 | 75.5 | 21.9 | 97.4 | 2.7 | 35.8 | 10.4 | 26.9 | 73.5 | 3.0 | 152.3 | 54.9 |
| July 10, 1900 | 73.4 | 29.7 | 103.1 | 3.2 | 43.8 | 0.0 | 28.1 | 75.0 | 3.5 | 153.6 | 50.5 |
| July 17, 1900 | 67.0 | 15.3 | 82.3 | 3.5 | 34.8 | 5.9 | 27.5 | 66.1 | 3.8 | 141.6 | 59.3 |
| July 25, 1900 | 65.8 | 22.7 | 88.5 | 3.3 | 32.8 | 5.0 | 31.7 | 69.8 | 3.9 | 147.4 | 58.9 |
| August 9, 1900 | 60.3 | 21.5 | 81.8 | 3.3 | 31.3 | 5.7 | 31.0 | 62.2 | 3.6 | 137.6 | 55.8 |
| August 17, 1900 | 51.0 | 16.3 | 67.3 | 2.4 | 28.3 | 5.7 | 23.2 | 52.0 | 3.7 | 115.3 | 48.0 |
| August 23, 1900 | 35.8 | 18.2 | 54.0 | .5 | 22.3 | 5.2 | 22.8 | 52.3 | 3.5 | 106.6 | 52.6 |
| August 29, 1900 | 43.5 | 17.6 | 61.1 | 3.0 | 28.3 | 4.6 | 21.4 | 48.6 | 3.6 | 109.5 | 48.4 |
| September 6, 1900 | 42.4 | 19.0 | 61.4 | 1.5 | 28.0 | 5.0 | 17.8 | 54.2 | 3.5 | 110.0 | 48.6 |
| September 13, 1900 | 42.4 | 19.0 | 61.4 | 1.5 | 26.2 | 5.0 | 17.6 | 53.9 | 3.5 | 107.7 | 46.3 |
| September 19, 1900 | 32.5 | 22.4 | 55.1 | .8 | 24.1 | 5.0 | 23.7 | 48.8 | 3.5 | 109.9 | 45.8 |
| September 26, 1900 | 31.6 | 23.0 | 54.6 | 1.5 | 24.1 | 5.0 | 20.5 | 53.5 | 3.5 | 108.1 | 53.5 |
| October 15, 1900 | 24.5 | 18.4 | 42.9 | .7 | 18.4 | 1.0 | 22.5 | 57.9 | 3.4 | 103.9 | 61.0 |
| May 2, 1901 | 12.0 | 12.6 | 24.6 | 0.0 | 21.7 | 1.4 | 19.3 | 21.5 | 2.5 | 66.4 | 41.8 |
| June 19, 1901 | 87.8 | 30.4 | 118.2 | 4.3 | 41.7 | 9.3 | 27.7 | 80.4 | 4.0 | 167.4 | 49.2 |
| July 16, 1901 | 76.3 | 28.3 | 104.6 | 3.5 | 36.8 | 10.4 | 26.6 | 60.8 | 4.5 | 142.6 | 38.0 |
| August 13, 1901 | 42.9 | 19.0 | 61.9 | 2.2 | 28.3 | 7.3 | 19.6 | 47.5 | 4.0 | 108.7 | 46.8 |

*Gain in flow of Jordan River between power plant and head of North Jordan Canal, 1901.*

[Measurements made by the water commissioner, J. Pewson Smith, jr.]

| Day. | June. | July. | August. | September. | October. |
|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* |
| 1 | | | | | 34.37 |
| 2 | | 40 | 40 | 34.37 | 34.37 |
| 3 | | | | | 34.37 |
| 4 | | | 40 | 34.37 | 34.37 |
| 5 | | | | | 34.37 |
| 6 | | 40 | 40 | 34.37 | 34.37 |
| 7 | | | | 34.37 | 34.37 |
| 8 | | | | | 34.37 |
| 9 | | 35 | 40 | 34.37 | 34.37 |
| 10 | | | 40 | 34.37 | 34.37 |
| 11 | | 35 | | 34.37 | 34.37 |
| 12 | | 35 | 40 | 34.37 | 34.37 |
| 13 | | | 40 | 34.37 | 34.37 |
| 14 | | | 42.3 | 34.37 | 34.37 |
| 15 | | | 42.3 | 34.37 | 34.37 |
| 16 | | 40 | | 34.37 | 29 |

*Gain in flow of Jordan River between power plant and head of North Jordan Canal, 1901*—Continued.

| Day. | June. | July. | August. | September. | October. |
|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* |
| 17 | | | 42.3 | 34.37 | |
| 18 | | | 42.3 | 34.37 | |
| 19 | | 40 | 42.3 | 34.37 | |
| 20 | | | 43.3 | 34.37 | |
| 21 | | | | 34.37 | |
| 22 | | | | 34.37 | |
| 23 | | 40 | 42.3 | 34.37 | |
| 24 | | | 42.3 | 34.37 | |
| 25 | | | | 34.37 | |
| 26 | | 40 | | 34.37 | |
| 27 | | 40 | 42.3 | 34.37 | |
| 28 | | 40 | | 34.37 | |
| 29 | 60 | 40 | | 34.37 | |
| 30 | | 40 | 42.3 | 34.37 | |
| 31 | | 40 | 34.37 | | |
| Daily average | | 40.36 | 41.96 | 34.37 | 34.37 |

The average gain shown by the measurements made during the season of 1900 is 54.2 cubic feet per second. The average flow of the Jordan River at the Narrows during June, July, August, and September, 1900, was 208.5 cubic feet per second, making the gain from seepage in the section of the river measured 26 per cent of the flow at the Narrows. The average gain from July 1 to October 15, 1901, was 38.30 cubic feet per second, or 30 per cent of the average flow of the river for the same period. No measurements have been made below the North Jordan Dam, but the gain in the flow of the river from seepage is known to be large. No direct relation between the quantity of return seepage and the flow of the river can be traced. There is a general correspondence, however, the volume of return seepage being large in the spring and diminishing as the season advances and the discharge of the river decreases. Aside from this general decrease in the volume of return seepage there is a daily fluctuation. These fluctuations do not follow the fluctuations in the discharge of the river, nor in the volumes diverted by the canals heading above the section under consideration, nor the changes in temperature. Although there are no observations to prove the fact, it is probable that there is a certain part of the increase which is practically constant and comes from seepage proper, and the variations are produced by surface drainage or waste water, the volume of which will vary with the lay of the particular pieces of land on which the water is being used at the time, and the manner of using the water. Although the volume of return seepage decreases with the decrease in the flow of the river, it is not proportional, the river falling much more rapidly than the seepage decreases. This has the same effect as an increased water supply during the latter part of the season. The canal companies store water in their own ground for future use, since it seeps out to the supply the lower rights and leaves the natural discharge of the river for the upper canals.

## THE SEASON OF 1902.

The studies on which this report is based were made during the summer of 1901, and the report was written during the autumn following. The extreme drought during that season aroused the people to the necessity of providing an increased water supply, but no active steps to that end were taken. The drought continued during the season of 1902 with increased severity, and has led to important developments, some of which have been referred to in the preceding pages. These developments have so changed the situation in the Jordan Valley that it has been thought best to bring the report down to date. The data necessary for this purpose have been furnished by E. R. Morgan and J. Fewson Smith, jr., water commissioners for Salt Lake County.

Irrigation began April 16, with the lake 1.67 feet below compromise level and the discharge of the river very small. As the season advanced the supply of water in the river became insignificant and at times almost ceased. Early in the season steps were taken for the establishment of a pumping plant at the head of the river, to raise the water from the lake and deliver it to the river. Owing to failure of the canal companies and the city to agree on the proposition, the installation of the pumps was delayed and none of them was placed in operation until August 11. Four were in use by September 10. The following description of the plant is taken from an article written by Angus M. Cannon, published in the Deseret News of September 20, 1902:

> These pumps were made especially for this work. They are 40-inch centrifugal pumps of the double-section pattern, having a suction and discharge 40 inches in diameter. They stand 10 feet high and weigh each about 12 tons. When the four pumps are all installed they will occupy a space 75 by 18 feet, and will throw 400 cubic feet of water per second. To operate these mammoth pumps there are four 100-horsepower Westinghouse induction motors and three transformers of 170 kilowatts each to transform the current from 16,000 volts to 500 volts. The motors weigh about 6,500 pounds each, and the transformers about 6,500 pounds each. The pumps are set on a concrete base, which rests on a pile and timber foundation, and they will be entirely surrounded by concrete, to keep out the water.
>
> At the west end of the foundation there are nine regulating gates, each 8 feet wide, to let the water flow out of the lake when the pumps are not in operation.
>
> The power for using these pumps is furnished by the Salt Lake City Water and Electrical Power Company.
>
> The cost of the plant when completed will be about $50,000.

The following statement regarding the operation of the pumps and the effect on the crops and land values was furnished by Mr. F. R. Morgan:

> The pumping plant was placed in operation (partly) August 11, with the lake showing an elevation of 3.08 feet below compromise point. Pumping for irrigation purposes ceased October 31, with the lake level at 4.19 feet below compromise point.
>
> From August 11 to October 31 there were 35,719.75 acre-feet delivered by the pumps, of which 35,684.10 acre-feet were delivered to the canals interested and 35.65 acre-feet escaped in the generation of power. The expense of pumping per acre-foot has been about 11.25 cents, but owing to irregularities due to wind, dredging, and defects of the pumping plant, expenses have been high. It is thought by those in charge of the plant and those interested that as experience is gained the expense will be considerably decreased. In technical units the expense of power is 1 cent per kilowatt per hour or about two-thirds of a cent per horsepower per hour, or about $48 per horsepower per annum.
>
> It is estimated that toward the latter part of the season about one-third of the water pumped by the plant was used in the generation of power sufficient to run the four pumps in operation. At the begin-

ning of the season, however, nearly 50 per cent was used for this purpose for the reason that a great amount of mud and sediment was elevated by the pumps, which decreased the amount of water pumped and increased the amount of work to be done.

One pump will be operated fourteen hours each day during the winter months to supply water to the canals for culinary and domestic purposes.

The area actually irrigated during the season of 1902 under the Utah and Salt Lake, South Jordan, and East Jordan canals varies from one-sixth to two-fifths of that irrigated when the supply is plentiful. The amount under the North Jordan probably lies between one-third and one-half of the amount usually irrigated. The yield under the three canals first named varied from total failure to one-fourth of a crop. This variation is probably due to the fact that some tried to irrigate all of their land with the water flowing naturally, thinking that the pumping plant would be installed in time to insure a full crop. The result in such cases was a total failure. Then, of course, some kinds of land require more water than others, and this can be taken as a factor of the result, as can also the methods used by different farmers. The North Jordan covers lower land, which has yielded somewhat better than that under the other canals. Probably one-third of a crop has been produced under it.

The data regarding the area irrigated and the part of a crop produced are, of necessity, only approximate, on account of the unsettled condition of affairs. The effect of the pumps on this year's crop was not appreciably felt, because the season for grain, potatoes, beets, etc., had passed before the pumps were installed. The alfalfa fields were for the most part in a parched condition and produced only pasturage for stock. The result will be seen in next year's crop, because the land irrigated late in August, September, and October will act as a reservoir and insure a partial supply for the crops next year. The effect of the pumps on the seepage going into Jordan River has not yet been noticed.

When water was plentiful, land without buildings or improvements but with water was worth from $60 to $120 per acre. During the summer, when the installation of the pumps was being opposed, the people became very much discouraged. Many of them contemplated the abandonment of their homes, as buyers could not be found at any price. Many farms were offered for sale for less than the improvements cost. But as soon as the plant began furnishing water the hopes of the people began to rise and land in some localities has again reached its normal price. In other cases farms are offered at 10 to 15 per cent below the prices asked when the natural flow was enough to irrigate their lands, and in some other parts people seem to be confident that higher prices than ever will be paid for land on account of the supply in August and September being insured (provided the lake holds out), which will make it possible for crops requiring late water to be grown.

The pumping plant was put in by the Utah and Salt Lake, the East Jordan, and the South Jordan canal companies. During this year the North Jordan Canal has been supplied by seepage water, and Salt Lake City has purchased what water it has received from the companies putting in the plant. It is expected that before next season opens the North Jordan Company will unite with the others.

So far these companies have worked together for the one purpose of establishing and operating the pumping plant. In the past there have been frequent attempts to merge them in order that the water supply might be used to better advantage, and in order that they might work together to increase their supply. The advantages of such a union are appreciated by all, but the difficulty of finding a satisfactory basis for turning stock of the old companies into stock in a new company has prevented such action. The drought has compelled the people to overlook these matters of detail, and it seems probable that a union of all interests will be brought about.

## PLANS FOR THE FUTURE.

A mass meeting was held at West Jordan in the latter part of August, 1901, to consider plans for preventing a shortage for another year. The plans ratified by the meeting included the consolidation of the four irrigation companies having equal

rights in the river; the establishment of a pumping plant at the outlet of Utah Lake to draw the water down below the level to which it can at present be drained; the purchase or condemnation of the lands immediately adjoining Utah Lake, so that the lake can be raised above the present compromise level without making the companies liable for damages; the securing of rights to water from the Weber and Duchesne rivers, the water to be brought to Utah Lake by way of the Provo River, and the enjoining of canal owners on the Provo River from diverting water from that stream.

The pumping plant has been established, but it remains to be seen whether it will be only a temporary relief or will permanently increase the supply. There have been several propositions for dredging the river from its head to the Narrows in order to draw the water from the lake to a lower level. The chief objection to these plans has been the expense. The pumping plant has been established as a means of accomplishing the same result at a smaller expense. There is no question but the initial outlay is much less, but whether it will be cheaper in the long run depends altogether on the supply of water entering the lake. The river once dredged and a dam built for controlling the flow, the expense ceases. If the water supply of the lake is not increased, pumping the water out means an increased supply for irrigation for the first year and after that a drop back to the old supply, with the expense of pumping what was before obtained by natural flow. This expense, according to the estimates made by the friends of the pumping scheme, will not exceed the interest on the expenditure necessary to dredge the river channel.

Either pumping or dredging will increase the available storage capacity of the lake by the volume which is drawn off. In many years it is necessary to turn water down the river during the winter to keep the water in the lake from rising above the compromise level. In such years this added storage capacity will be a great advantage, and pumping will be necessary only during the late summer. The supply of water which can be stored in the lake below compromise level, with the water drawn down a few feet below the present low-water mark, is sufficient for the lands now irrigated. The trouble will be that there is no reserve for years of short supply like the three seasons just past, and in those years the crops will suffer.

### BUYING LANDS BORDERING ON UTAH LAKE.

The compromise agreement limits the height to which the water in Utah Lake may be raised by the dams in the Jordan. As has been stated, it is necessary in many years to turn water down the river when it is not needed for irrigation to avoid raising the lake above compromise level. The purchase of the lands bordering the lake would remove this restriction and enable the canal companies to hold all the water that might come in any year, and if there was more than was needed during that year to hold it over for another year. In this way the surplus of the wet years could be held to tide over the dry years instead of wasting into Great Salt Lake. When the land has been purchased there will be no further expense for maintaining the reservoir. The increased capacity made available by raising the water 5 feet above compromise level is estimated by the city engineer of Salt Lake City at 520,000 acre-feet, more than twice the capacity of the lake between compromise and low-water levels. The area which would be submerged is about 22,000 acres. Much of this land is worth very little, while some of it is quite valuable. It is hardly worth while

to make an estimate of the cost of getting title to the land, but it certainly would be cheap storage as compared with most reservoirs.

There is some question, of course, of the supply of water being sufficient to fill this reservoir. The inflow during the past few years has not raised the lake to compromise level, and there are other seasons on record when water went above compromise with no obstruction in the river. Although data are not at hand to get the average elevation of the lake, it is quite probable that the water could be controlled so as to provide an ample supply every year if the restrictions of the compromise agreement were removed. It is very likely that only at rare intervals the water would be raised to the full 5 feet above compromise, so that much of the land belonging to the reservoir site could be leased for pasture or hay and in that way repay at least a part of its purchase price. It is also proposed to reduce the area of the lake and increase its depth in order to lessen the loss from evaporation. The plan is to fill some of the shallow places around the margin of the lake with mud pumped from other parts. In this way the efficiency of the lake as a reservoir would be greatly increased, and a large area of land now swampy would be made available for cultivation. This double gain would much more than repay the expense of making the improvement. (See page 36.)

### SECURING WATER FROM THE WEBER AND DUCHESNE RIVERS.

There are no engineering difficulties in the way of turning water from the headwaters of Weber and Duchesne rivers into the tributaries of the Provo River, but there would undoubtedly be a legal fight. There is already a shortage of water on the Weber River during all but the flood seasons, and the Duchesne is entirely within the Uinta Indian Reservation. In view of these facts and the good average supply furnished by the tributaries of Utah Lake it is very doubtful whether the chance of getting water from these sources is worth the legal expenditure necessary to get the title, in case the Jordan Valley parties win, which is very doubtful.

### ENJOINING DIVERSIONS FROM PROVO RIVER.

None of the large canals in the Jordan Valley was completed to its present size until about 1880, and the canals on the Provo date their rights from 1849 to 1880, since which time there have been no diversions of any size. It is almost certain that any court would decide against the Jordan canals and in favor of the Provo canals, if the question of priority should be brought up. It is quite likely that the Jordan companies could prevent storage on the tributaries of Utah Lake or any new diversions from these streams, but the existing canals for the most part antedate the Jordan canals, and hence can not be interfered with.

That at least a part of the people of the valley believe that an increased water supply is to be obtained is evidenced by the filing made on Utah Lake by George C. Lambert, who has deeded his rights under it to the canal companies. The plan, as outlined in the notice filed, is as follows:

The channel of the river is to be dredged from the lake to the head of the East Jordan Canal, so as to carry 1,000 cubic feet per second. The East Jordan Canal is to be enlarged from its head to a point opposite the head of the South Jordan Canal, so as to carry 600 cubic feet per second, and from that point on to a capacity of 400

cubic feet per second. The canal is to be extended on its present level around the eastern part of Salt Lake County, past Salt Lake City into Davis County. At the head of the South Jordan Canal a new power house for generating electricity is to be built and 200 cubic feet per second of the water diverted by the East Jordan Canal is to be dropped through this power house to the South Jordan Canal. The power generated here is to be used to pump the water from the lake to the river to supply the canals. The Utah and Salt Lake Canal is to take 400 of the 1,000 cubic feet per second of water raised by the pumps and be enlarged and extended round the north end of Salt Lake, to irrigate land in Tooele County. To supply water for this enlargement the lake is to be drawn down to 7½ feet below compromise point if necessary.

This plan is, in general, simply an enlargement of the present arrangement. The water is at present raised by pumps operated by power generated by dropping a part of the water raised from the Utah and Salt Lake Canal to the South Jordan Canal and the river. The new plan would mean an abandonment of the present power plant and taking the water through the South Jordan Canal instead of the Utah and Salt Lake Canal. The lands under the canals, as they exist at present, can use to good advantage all the water the lake supplies, and unless a largely increased supply is obtained it is hardly worth while to make a change.

## GENERAL DISCUSSION.

The nature of a right to water in Utah is defined in the law of 1880, as follows:

> Such right may be appurtenant to the land upon which such water is used, or it may be personal property, at the option of the rightful owner of such right, and a change of the place of use of water shall in no manner affect the validity of any person's right to use water, but no person shall change the place of use of water, to the damage of his coowners in such right, without just compensation. (Rev. Stat. 1888, sec. 2782.)

The law of 1897 again declared that a water right might be treated as personal property and be conveyed separately from the land on which it had been used.[a]

In the Jordan River decree the court named the individuals entitled to water from the small ditches and gave the areas which they are entitled to irrigate, but named no parties under the large canals. Stockholders in the latter companies apparently have not, under this decision, any rights in the river as individuals, but only through the companies. The nature of the rights of such persons is, then, defined by the rules of the companies, not by the laws of the State. Under the canals under discussion rights are personal property, and may be transferred independently of any land, or may be owned by parties having no land, who may rent the water to be used on different land each year, so that at present the rights of farmers having direct claims on the river and those having stock in canal companies do not differ essentially, except that the latter are limited in their rights of transfer to the lands which are reached by their respective canals; but this similarity may be destroyed at any time by a change in the rules of a canal company. The total area watered by all the small canals is only 1,627.25 acres, so that the nature of the water rights of almost all the Jordan Valley farmers

[a] Revised Statutes of Utah, 1898, sec. 1281.

is determined by the rules of canal companies composed of these same farmers. This gives great importance to the form of these organizations. This has been fully described in the preceding pages. The stock of the companies is very largely owned by those who use the water; these water users elect the boards of directors who formulate the rules which define their rights, and these rules are referred to a vote of the stockholders. They also elect the officers who enforce the rules, and vote all assessments. For the operation of a completed canal or for the building of a canal by parties who own the land to be watered and have the capital necessary to build their works, this form of organization is ideal; for the building of a canal for the use of those who must secure outside capital it may be dangerous. If a majority of the stock of a company is held by others than water users, the rules affecting the rights of the users may be changed at any time without their consent and to their disadvantage, making their industry uncertain and, therefore, unsatisfactory. Under such circumstances a company disposing of water under contracts strictly defining the rights and duties of both parties is preferable to such stock companies as those owning the Jordan canals. There is a possibility of the concentration of the stock of the present companies in the hands of others than water users and the prescribing of rules unjust to those who must then rent water from these owners, but the tendency is in the opposite direction.

Indirectly the rights of all water users depend on the laws of the State and their enforcement. Looking at the situation from this standpoint, the people of the Jordan Valley have not the same reason for congratulation as when considering the organization of their companies. Their rights, through these companies, to whatever water enters Utah Lake have been defined and will undoubtedly be protected by the water masters or by the courts, but the quantity of water entering the lake is subject to other than natural influences, which are beyond the reach of the commissioner appointed by Salt Lake County. The Jordan River is treated as complete in itself, while in fact its water supply comes from the tributaries of Utah Lake, each of which is treated as complete in itself and not as tributary to Jordan River. These tributaries are entirely beyond the jurisdiction of any commissioner appointed by Salt Lake County, since they do not reach that county, and so far no court has attempted to establish any relation between rights to Jordan River and rights to the tributaries of Utah Lake. Diversions from these tributaries undoubtedly affect the flow of Jordan River, and this relation should be recognized. Rights to these streams are not county matters, as was recognized by the law of 1880, which provided for intercounty boards, but when the law of 1901 was enacted this fact seems to have been overlooked. This law should be amended either by providing for intercounty commissioners or by making the protection of water rights a State matter or providing for the appointment of commissioners whose jurisdiction would be governed by drainage lines rather than county lines.

Another weakness in the present laws has been growing more and more apparent during the past few years, and it is a weakness which is fundamental and can not be corrected except by revolutionizing the water laws of the State, or rather by returning to the system "of the fathers." This weakness consists in treating the whole question of water rights as a judicial rather than an administrative question. The situation can be best illustrated by the history of the establishment of a right to

the waters contained in Utah Lake below the level to which it can at present be drawn off without pumping. January 30, 1900, the city of Salt Lake, through its engineer, posted and filed a notice claiming the water in the lake 1½ feet below low-water mark, to be drawn off by lowering the bed of Jordan River from its head to the dam in the Narrows. Surveys were made during the summer of 1900, but nothing more has been done in the more than two years since that time toward perfecting this right. In the spring of 1902 the canal companies decided to build a pumping plant to increase the flow of Jordan River. There was uncertainty as to whether the city had acquired any right by posting the notice above referred to, but there was no way of deciding this under the law but by putting in the pumps and waiting for the city to attempt to assert a right to the water. This course might have turned out all right, but, on the other hand, it might have resulted in the practical throwing away of all the money put into the plant. Rather than take this risk, three of the canal companies paid the city $5,625 for a three-fourths interest in whatever right it might be held to have acquired, and a like interest in 10 acres of land at the head of the river, which is said to have cost the city about $1,000. To further guard against trouble in the future, these companies also posted and filed a new notice, claiming for themselves the right to the water covered by the notice of the city. Counting that $625 was paid for an interest in 10 acres of land, the companies have paid $5,000 for immunity from the results of the weakness of a system which leaves all questions of water rights to the courts. Had there been administrative supervision of the acquirement of rights there would be a record of rights, and the canal companies could have gone to this record and found out whether anything stood in the way of their project, instead of paying $5,000 to a party which should have been compelled to perfect its right or relinquish its claim. The settlement of conflicting claims is perhaps properly a judicial function, but there should be some method of having a right defined before it is brought into conflict, and that is not a judicial matter. The creation of a board of control was proposed in the constitutional convention of Utah, but was coupled with a declaration of State ownership of all water in the State. It was feared that this meant a confiscation of water rights already vested, and although the fallacy of this notion was pointed out, the fear defeated the board of control. Yet, it is no more necessary to couple State ownership with State control than it is to declare that all land belongs to the State before the legislature may pass laws regulating transfers of land. The Colorado supreme court has justified the system of public control in that State, as an exercise of the police powers of the State, and a similar system for Utah can be based upon the same powers, even admitting that the State has no ownership in the water. The creation of a board of control is then a question of expediency, not one of right. The present system is well illustrated by the Jordan situation. A court defined the rights as they existed at the time the suit was brought, and, recognizing that it could not anticipate all the questions which might arise, retained jurisdiction for the purpose of making such modifications of its decree as might be necessary. A commissioner was appointed to enforce the decree. Since that time various questions have arisen, and in every case these questions have been decided by the water commissioner, pending a ruling by the court. Since the court kept the case open, such rulings can be obtained by the water commissioner by an application for instructions. Had the case been closed, as

most of them are, the water commissioner would decide all questions which arise, and anyone dissatisfied with his rulings would be obliged to bring suit to have them set aside. Where water commissioners are appointed by the county commissioners the situation does not differ from that just described. The commissioner decides all questions which arise, and the only recourse of anyone dissatisfied with his rulings is an appeal to the courts. Such a proceeding is slow and expensive. An attorney must be employed and a regular trial gone through with, involving a large expenditure of money and time. Under the system in force in the States having public control, the water commissioner decides the question, as he does in Utah, but appeal from his decision is taken to the superintendent of his water division or to the State engineer, without the formality of a trial and the expense of an attorney. In fact, Utah has the substance of public control, without its advantages.

The people of Utah are conservative and dread any innovation, and have, therefore, defeated all recent attempts to place the water of the State under a recognized system of public control. The records quoted in this report show that this is no innovation. The waters of the Jordan, at least, were under public control, and rights were acquired by grant, not by appropriation. After the river was all diverted this control relaxed and the people seem to have forgotten that it ever existed. The form of the board of control is new, but the principle is that of the State of Deseret, and of the Territory of Utah in its earlier years, and has been already adopted in substance in the law of 1901. Would it not be well to go the rest of the way and secure the advantages to be gained by recognizing this fact and providing a cheap and convenient system of administration of streams, instead of leaving it to the courts? Litigation over water rights is new in the Jordan Valley, there being but the one case above referred to which can be properly called a water-right case. That case, which cost the litigants more that $20,000, and the recent controversies which have been precipitated by a series of dry years, will lead, it is believed, to a strong sentiment in favor of a return to the original system—all water privileges under the control of an administrative board.

# IRRIGATION IN UTAH LAKE DRAINAGE SYSTEM.

By ARTHUR P. STOVER,
*Assistant in Irrigation Investigations.*

## THE UTAH LAKE DRAINAGE BASIN.

Soon after their settlement in Great Salt Lake Valley, in 1847, the Mormon pioneers began the systematic settlement of other near-lying valleys. As was natural under the circumstances, the localities first chosen for settlement were those which were most favored by natural conditions and which offered to the settler the least hardship and danger in their reclamation. As these sections became settled, others more remote and with less inviting climates and natural conditions were converted into homes.

In the spring of 1849 a number of families, under the direction of the church, entered Utah Lake Valley (map, Pl. VI), lying just south of Salt Lake Valley. Thirty families located on Provo River, about 2 miles west of the present site of Provo City. Others settled near the present sites of Lehi, American Fork, and Pleasant Grove, on streams which emerge from the mountains at these points, while others located on Spanish Fork River, some distance west of the present location of the town of Spanish Fork. Each year the amount of land brought under cultivation was rapidly increased and settlement extended to different parts of the valley. Soon the tide of settlement turned toward the smaller valleys lying on the tributary streams. In 1858 the first settlement in Provo Valley was made, and the year following Juab and Goshen valleys, lying to the south of Utah Lake Valley, were settled.

The Utah Lake drainage basin is located in the north-central part of the State, lying just south of Salt Lake Valley and west of the main range of the Wasatch Mountains, embracing all of Utah County and portions of Wasatch, Summit, and Juab counties. It has an area of about 3,600 square miles, of which nearly nine-tenths is rough, mountainous country, some portions of which attain an elevation of from 10,000 to 12,000 feet above sea level. This mountainous section lies to the east and southeast of Utah Lake. To the west and southwest of the lake the country consists of rolling hills and low mountains. The sections that are subject to cultivation are situated in Utah Lake Valley and in the valleys and small openings along the larger streams tributary to the lake. The greater part of the cultivable area in Utah Lake Valley lies to the east and south of the lake. To the west of the lake is Cedar Valley, which contains thousands of acres of arable land, but is useful only as a stock range, as there is no water available for irrigation.

## IRRIGABLE AND IRRIGATED LANDS.

The area of cultivable land aggregates 400 square miles, or about one-ninth of the entire area of the drainage basin. This area is confined to Utah Lake Valley, which includes Goshen Valley at the southern extremity of the lake, and to the level portions of the valleys and openings along the larger streams of the system. Of the latter, Provo and Kamas valleys, on Provo River, and Juab Valley, on Currant Creek, are the most important.

In general the soil distribution in the several valleys is quite similar. Surrounding the valley and lying next to the foothills are what are termed "bench lands" or "benches." These benches mark the shore lines of the ancient Lake Bonneville, the water of which, in prehistoric ages, covered the greater part of the interior basin of the present State of Utah. They have been formed of a heterogeneous mass of disintegrated stone and gravel washed from the surrounding hills, and are of a gravelly nature, varying in depth from 6 inches to 3 or 4 feet in some localities. The subsoil is generally a loose, coarse gravel with occasionally a layer of gravelly cement. In the central portions of the valleys the soil is more sandy, and in the lower parts the sedimentary deposit is quite deep, forming a rich, heavy soil having, as a rule, a stiff clay subsoil. In all these valleys the bottom lands were almost without exception the first to be reclaimed and cultivated, not because the soil was the best, but because it was more easily watered. As the higher lands came under cultivation and the excess of water used in their irrigation began to manifest itself in the form of seepage, the bottom lands became too wet for successful cultivation and were converted into meadows, which are used as hay lands and for pastures.

The climatic conditions in Utah Lake, Goshen, and Juab valleys are much more favorable to the growth of the majority of crops, and especially fruit, than are those of the other valleys of the system. The average altitude of the three first-named valleys ranges between 4,500 and 4,700 feet above sea level, while the altitude of Provo Valley is about 5,500 feet, and that of Kamas Valley between 6,000 and 7,000 feet above sea level. The climate, especially in Utah Lake Valley, is tempered to an appreciable extent by the great body of water in Utah Lake.

## THE WATER SUPPLY.

There are very few localities in the intermountain region that are favored with a better or more reliable water supply. The broad and high Wasatch range of mountains on the east, whose summits are covered with timber and heavy undergrowth, furnishes a constant and plentiful supply of pure water. Of the many streams tributary to the lake the most important in order of size are Provo River, which has its rise in the northeastern part of the drainage basin, whence it flows in a southwesterly direction toward the lake; Spanish Fork River, which rises in the southeastern part of the drainage basin and flows northwest toward the lake, and American Fork River, which, rising in the extreme northern part of the system, flows in a southerly direction, entering Utah Lake Valley at a point about 10 miles north of the point at which Provo River enters. There are a number of creeks, the most important of which are Currant Creek in the southern part of the basin; Hobble Creek, which emerges from the mountains some 4 or 5 miles north of the mouth of Spanish Fork Canyon; Santaquin Creek and Payson or Peteeneet Creek, which rise

in the southeastern part of the basin, and Dry Creek, which has its rise in the extreme northern part of the basin. In addition to the water supply derived from the sources just mentioned, there are a number of minor creeks and springs which irrigate a considerable area.

Utah Lake, to which these streams are tributary, is a body of fresh water, located a few miles northeast of the center of its drainage system. Its length north and south is about 22 miles, and its width east and west 9 or 10 miles. Its surface area at Compromise Point[a] is estimated at 93,000 acres or a little more than 160 square miles. The lake is shallow, its extreme depth perhaps not exceeding 15 or 20 feet. The outlet of the lake is at its northern extremity, the water being discharged into the Jordan River, which flows north for a distance of about 40 miles and empties into Great Salt Lake.

During the spring months the streams tributary to the lake are subject to a flood flow, which lasts from two to six weeks, depending upon the nature of the winter preceding and also upon the nature of the spring season. The lake serves as an equalizer of the flow of the Jordan River, the great volume of water received during floods finding its way out gradually through that stream.

There are few if any natural reservoir sites in the intermountain region that are more favored by natural conditions and surroundings than is Utah Lake. On the north, east, and south the land slopes gradually from the lake to the foothills and mountains which form the rim of the valley; on the west the rise of the country is more abrupt, the Lake Mountains, a short range separating Cedar Valley from Utah Valley, forming the western shore of the lake for a considerable distance. The geological structure of the region is also favorable for the effective storage of water in the lake.

With but few exceptions, the entire flood flow of all the streams just mentioned is available for storage in Utah Lake. These exceptions are Currant Creek in the southern part of the system, upon which is situated the reservoir of the Mount Nebo Irrigation Company, which stores all the surplus water of Currant Creek, and Payson Creek, upon which there are a number of small reservoirs that are filled with water. There are also a few small reservoirs that control a small portion of the flood flow of the streams upon which they are located. These streams, however, are comparatively small, and their surplus waters would not be of much consideration were they available. The larger part of the water that can be stored in the lake is discharged from the Provo River, whose flood flow in some years is between 1,500 and 2,000 cubic feet per second, and from Spanish Fork River and American Fork River, each of which during high-water seasons has a discharge of several hundred cubic feet per second. Although the normal flow of all tributary streams is diverted for irrigation, a large part of the water in time reaches the lake in form of seepage.

Since 1872 the owners of canals diverting water from Jordan River below the Narrows (see page 42) have, by means of timber dams placed in the river, stored water in the lake during the winter season for use during the irrigation season following. They have been restrained from raising its level above Compromise Point

[a] By an agreement between the canal owners on the Jordan River and the owners of land along the shores of the lake, a point some 3 feet above low-water mark was defined as the point to which the level of the lake could be raised by means of a dam in the Jordan River belonging to the parties first mentioned. This point is known as "Compromise Point." See page 64.

by the owners of the land which is inundated when the water is raised above this point.

The investigations on Spanish Fork River are given in detail by A. F. Doremus, State engineer, and are, therefore, omitted from this part of the discussion. (See pages 157–170.) The other streams of this system are taken up in the order of their seeming importance.

## PROVO RIVER.

The Provo River is by far the largest tributary of the Utah Lake-Jordan River system. It has its rise in the summits of the Uinta Mountains in Summit and Wasatch counties. The head of the river is about 70 miles distant from its mouth. In this distance the river passes through a succession of valleys separated from each other by narrow canyons. These valleys contain quite large tracts of land which can be cultivated. The soil is generally rich, consisting principally of silt deposited by the river.

The river has its source in a number of small lakes, among which the more important are Washington Lake, whose surface area is about 50 acres; Lake Trio, area 25 acres; and Rose Lake, area 20 acres. This group of lakes is situated in close proximity to other groups of lakes, which are the sources of the Bear, Weber, and Duchesne rivers. The river is fed all along its course by numerous tributaries. The water of the more important tributaries is, however, largely used for irrigation before they reach the river, and in times of low water their flow is entirely diverted, no water reaching the river except as seepage.

From its source the river flows through narrow canyons in a southwesterly direction for about 20 miles, then enters the Kamas Valley. In this distance there are only a few small ranches scattered along at points where the canyon widens out sufficiently to leave a few acres of level land.

Through the Kamas Valley the river takes a northwesterly direction for a distance of 4 or 5 miles, and again enters a narrow canyon 10 or 12 miles long, from which it enters the northern extremity of Provo Valley, the second largest valley on the Provo River. From its point of entrance the stream takes a southwesterly course through the center of the valley for 7 or 8 miles, when it again passes into a canyon, which it follows for 12 or 15 miles, emerging into the broad, gently sloping expanse of Utah Lake Valley. From the mouth of Provo Canyon the river flows almost due south for a distance of 5 miles, thence, taking a westerly direction, enters the lake some 3 miles west of Provo City.

The drainage area of Provo River comprises about 800 or 1,000 square miles, consisting largely of broken mountainous country, covered for the most part with a forest growth of quaking asp, pine, cedar, scrub oak, and maple. The northern slopes of the mountains, covered with undergrowth and protected from wind and sun by high cliffs and ridges, form natural storage reservoirs for the winter's snow and rain.

The area susceptible of irrigation from Provo River and its tributaries lies largely in three valleys: Kamas and Provo valleys on the upper reaches of the river, and that part of Utah Lake Valley which is dependent upon Provo River for its water supply.

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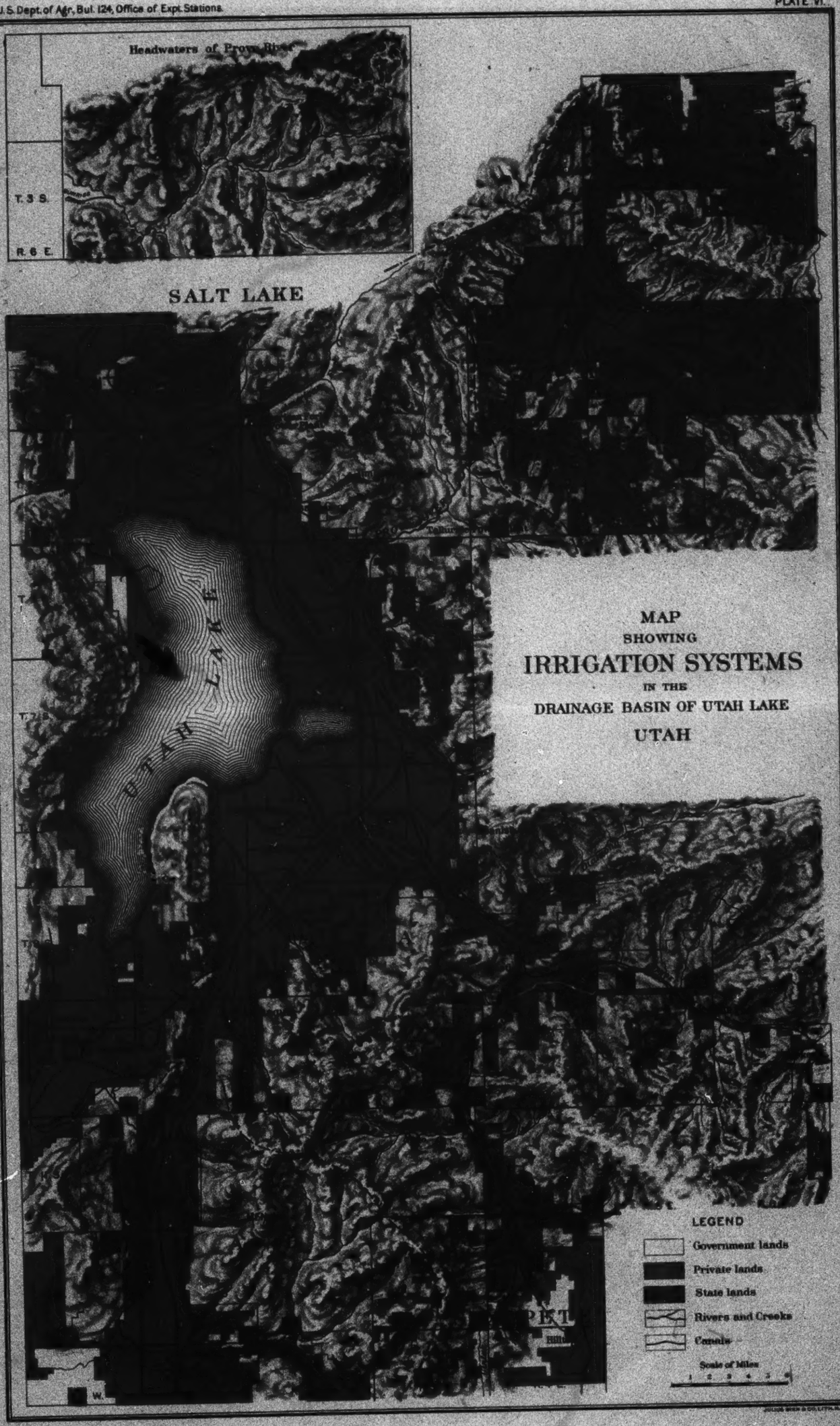

Headwaters of Provo River
T. 3 S.
R. 6 E.
SALT LAKE
UTAH LAKE
MAP
SHOWING
IRRIGATION SYSTEMS
IN THE
DRAINAGE BASIN OF UTAH LAKE
UTAH
LEGEND
Government lands
Private lands
State lands
Rivers and Creeks
Canals
Scale of Miles
1 2 3 4 5 6

## KAMAS VALLEY.

Kamas Valley is about 10 miles in length, north and south, by 4 or 5 miles in width. Provo River enters the valley at its southeast corner and, flowing across the south end of the valley, leaves it at the southwest corner. Weber River, flowing in a westerly direction, crosses the northern end of the valley, while Beaver Creek, a tributary of the Weber, enters near the center of the eastern side of the valley, flows in a northwesterly direction, and joins the Weber near its point of exit from the valley. It is an interesting fact that these two rivers are so located that water may be diverted from the Weber and carried over into the Provo, or from the Provo and carried into the Weber.

The section of Kamas Valley traversed by Provo River is considerably lower than the rest of the valley. The "river bottoms" vary from one-fourth mile to 1 mile in width and form a large part of the area irrigated from the Provo. The remainder of the area irrigated from Provo River lies on the north side of the river on a general level with the remainder of the valley, and at an elevation of 50 or 60 feet above the bottoms. This section is called Kamas Bench. On the south side of the river the mountains rise quite abruptly, leaving but a small area which is under cultivation.

The average elevation of the valley above sea level is between 6,000 and 7,000 feet. The climate is such that only the hardier crops, such as hay and grain, are profitably grown.

### SUNRISE CANAL.

The canals of Kamas Valley are quite small, and are, without exception, either community ditches or private ditches. The highest canal diverts water for the Sunrise Irrigation Canal and Moons Mill Race. The head of the joint canal is on the north side of the river, about 1½ miles above the mouth of the canyon. The water is diverted by means of a temporary dam of logs, stones, and manure. A pile of stones serves as a head gate, these being thrown into the canal channel, or taken out, as the flow is to be increased or decreased. From the head the joint canal takes a westerly course, following the river for about three-fourths of a mile before it divides. The Sunrise Canal continues along the river for a few hundred yards, then crosses in a crude flume supported on log trestles. After crossing the river the canal follows the sidehill for a short distance, gaining the top of a small bench, on which part of its water is used for irrigation. From this point the canal follows the foothills for about 3 miles, supplying water for the land which lies between it and the river. This canal is owned and operated by the Sunrise Irrigation Company, a company consisting of farmers, and incorporated in 1895 with a capital stock of $10,000, divided into 1,000 shares. The area irrigated is 250 acres. The amount of water to which the canal is entitled, by virtue of a decree (see page 133) issued by the district court in May, 1899, is 4.5 cubic feet per second.

### MOONS MILL RACE.

The water for this race is obtained from the joint canal just described. From the point of division the canal runs in a northwesterly direction for a distance of one-

half mile, at which point the water is used for running a sawmill. The water after leaving the mill is turned back into the river channel. There is no irrigation from this canal.

### SOUTH KAMAS CANAL.

The South Kamas Canal is the second in elevation diverting water from the river and is the largest and oldest company ditch in the valley. It is at present owned by the South Kamas Irrigation Company, incorporated February 27, 1896. For many years prior to the company's incorporation the ditch was owned and operated by the farmers owning the lands served. The head gate of the ditch is on the north side of the river, about 2 miles above the settlement of Woodland. The head works consist of a temporary dam of the prevailing type, and a rough flume some 20 to 30 feet in length, which serves the combined purpose of head gate, overflow, and regulating gate.

The canal takes a northwesterly course, and gains the general level of the valley in about 3 miles. From this point it takes a northerly course and skirts the foothills along the eastern border of the valley for 2 or 3 miles, then, turning almost due west, it extends for about 3 miles, the total length approximating 7 miles. The canal as first constructed in 1875 had a width of 2 feet and a depth of 1½ feet. Between 1879 and 1886 it was enlarged to a width of 6 feet and depth of 1½ feet, with a fall of 3 inches per 100 feet, and the amount of water diverted was increased sufficiently to irrigate from 1,800 to 2,000 acres of land. The area irrigated from the canal at the present time is given at 2,062 acres. One thousand acres, however, is entitled to water only when there is a surplus over the needs of those having primary rights[a] to the stream. The amount of water to which this canal is entitled by virtue of a decree of the court is 16⅔ cubic feet per second for 1,050 acres as a primary right, and 11⅓ cubic feet per second for 700 acres as a secondary right.

### WASHINGTON CANAL.

This canal is owned and operated by the Washington Irrigation Company, an incorporated company, with a capital stock of $3,400, which is divided into shares having a par value of $10. It is the third canal in elevation diverting water from Provo River. Its head gate is on the north side of the river about one-fourth of a mile below the head of the South Kamas Canal. The canal was constructed in the spring of 1890. For a portion of its length what was previously known as the Phillips Ditch was used, the Washington Canal succeeding to the rights of this ditch, which were acquired in 1876 or 1877. The canal as now constructed is 7 feet wide on top, 5 feet wide on the bottom, and 2 feet deep, with a carrying capacity of about 60 cubic feet per second. The head gate is a framed structure 8 feet in width, hav-

[a] Under an act passed February 20, 1880, water rights were divided into classes. What are termed primary rights cover the natural low-water flow of a stream and entitle the holder to water to the extent of his reasonable necessities at any time during the season. Secondary rights entitle the holder to water when the flow of the stream is in excess of the needs of holders of primary rights; third rights taking water after both first and second rights are satisfied, and so on. The latest comer is the first to be deprived of water, those settling prior to him losing their supply in opposite order to that in which their rights were acquired, as the flow of the stream diminishes.

ing two 4-foot gates which are raised and lowered by hand. The dam is of the temporary type. The canal follows the sidehill in a course parallel to the South Kamas Canal and but a short distance below it, gaining the level of the valley about a quarter mile below the point at which the South Kamas Canal gains the top. From this point it follows the contour of the valley in a northwesterly direction for 4 or 5 miles. The area irrigated, as given by the president of the company, is 1,200 acres. The canal is entitled to $21\frac{1}{5}$ cubic feet of water per second. This, however, is a fifth right, and the canal receives water only during the high-water season, which, as a rule, lasts until about July 1.

The above are the only community ditches in the Kamas Valley taking water from Provo River. There are, however, a number of small private ditches[a] which are owned and controlled by individuals. The average amount of water to which these ditches are entitled is less than one cubic foot per second.

In the following summary is given the discharge of the more important of the Kamas Valley canals as measured at different times during the season of 1900:

*Discharge of canals in Kamas Valley.*

| | Cu. ft. per sec. |
|---|---|
| Moons Mill Race: | |
| July 11 | 14.090 |
| August 3 | 8.760 |
| August 21 | 8.350 |
| Sunrise Canal: | |
| June 27 | 7.320 |
| July 11 | 5.185 |
| August 3 | 3.430 |
| August 21 | 2.829 |
| South Kamas Canal: | |
| June 27 | 31.200 |
| July 11 | 23.210 |
| August 3 | 15.190 |
| August 21 | 14.290 |
| Washington Canal: | |
| July 27 | 14.700 |

July 11 the Washington Canal carried 2.15 cubic feet per second belonging to individuals, not to the company. August 3 there was no water entering the head of the canal. Probably 3 cubic feet per second entered the canal in the first half mile by seepage from the South Kamas Canal.

From Kamas Valley the river passes into a narrow canyon which extends in a westerly direction for 6 miles, thence takes a southerly direction for a distance of 4 miles, and opens into the northern extremity of Provo Valley.

## TUNNEL CREEK.

At several points along its course through the canyon the river is fed by small streams. The most important of these, and the only one that will be considered here, is Tunnel Creek, which enters the river some 4 or 5 miles from the lower end of the canyon. Except in flood season, its flow comes mainly from the Ontario Drain

[a] A list of water users in both Kamas and Prove valleys is given in connection with the discussion of case of Wasatch Irrigation Company et al. *v.* Edward Fulton et al. (page 133).

Tunnel, which was constructed in 1891 for the purpose of draining the lower levels of the Ontario, Daly West, and Silver King mines, located near Park City in Summit County, in the drainage basin of the Weber River. The tunnel was driven from the lower levels of the mines in a southeasterly direction, piercing the divide between the basins of Provo and Weber rivers, and came out on the Provo side of the divide some 2 miles below the summit. Throughout the greater part of its length of 4 miles the tunnel receives water from underground sources, so that the volume discharged at its mouth is considerably in excess of the amount that is actually drained from the mines. The discharge averaged about 25 cubic feet per second when the tunnel was constructed; the average discharge during the summer season of 1900 was between 15 and 17 cubic feet per second. From the mouth of the tunnel the water is conveyed, by means of flume and steel piping, to a small electric-power plant, from which the power is transmitted to the mine on the other side of the mountains.

At the point where Tunnel Creek enters the river the canyon widens and forms a considerable area of level land, which is subject to cultivation. Prior to the construction of the Ontario Drain Tunnel, 25 acres of this area drew its supply of water from the river. Since the construction of the tunnel, however, its water supply has been taken from Tunnel Creek.

Scattered all along the canyon are numerous small ranches, varying in size from 1 to 115 acres, which receive their water supply from small individual ditches which tap the river at points near the land they irrigate.

## PROVO VALLEY.

This valley is the second largest on the Provo. Its greatest width east and west is about 6 miles, and its length north and south some 7 or 8 miles. The arable land aggregates 24,000 acres, of which from one-half to two-thirds is irrigated. The elevation of the valley above sea level ranges from 5,400 to 5,600 feet. The climate, with the exception of being somewhat colder, is not widely different from that of Utah Lake Valley. The crops common to the lower valleys, with the exception of the more tender fruits, are raised successfully. Hay and grain are the staple crops.

Provo River enters the valley at its northern extremity and leaves it at its southwestern corner. Three creeks enter the valley from the east and two from the west, the waters of which are used on land near the points at which they emerge from the mountains. The three creeks which enter from the east, named in order beginning at the north, are Lake Creek, which enters about 3 miles east of the town of Heber; Center Creek, which enters about 2 miles west of Lake Creek; and Daniels Creek, which enters at the southeast corner of the valley, 4 or 5 miles east of the town of Charleston. These creeks have their sources some 12 or 15 miles east of Provo Valley, near the divide between Provo and Duchesne rivers.

The flow of these creeks during the flood season is large. Several reservoirs have been constructed on their headwaters, and, though small, serve to materially increase the normal flow of the streams during the irrigation season. The following summary shows the flow of these creeks as measured at various times during the season of 1900, also the average flow of each for the whole irrigation season:

*Discharge of creeks entering Provo Valley from the east, 1900.*

| | Cu. ft. per sec. |
|---|---|
| Lake Creek: | |
| June 26 | 7.020 |
| July 10 | 3.818 |
| July 26 | 3.215 |
| August 4 | 3.420 |
| August 22 | 3.046 |
| September 12 | 2.680 |
| Average for season | 4.366 |
| Center Creek: | |
| June 26 | 9.270 |
| July 10 | 6.135 |
| July 26 | 5.282 |
| August 4 | 5.320 |
| August 22 | 5.097 |
| September 12 | 4.730 |
| Average for season | 5.972 |
| Daniels Creek: | |
| June 26 | 13.400 |
| July 10 | 9.324 |
| July 26 | 6.515 |
| August 4 | 5.600 |
| August 22 | 5.145 |
| September 12 | 4.357 |
| Average for season | 7.390 |

The waters of each of these creeks are controlled by incorporated companies composed of farmers. Following is a list of these companies:

*Incorporated companies taking water from Lake, Center, and Daniels creeks.*

| Name of company. | Date of incorporation. | Capital stock. | Number of shares. | Acres irrigated. | Place of business, Utah. |
|---|---|---|---|---|---|
| Lake Creek Irrigation Company | Aug. 6, 1888 | $20,000 | 2,000 | 500 | Heber. |
| Lake Creek Reservoir and Irrigation Company | Feb. 29, 1888 | 4,000 | 400 | 200 | Do. |
| Center Creek Irrigation Company | Mar. 25, 1886 | 5,000 | 500 | 600 | Center. |
| Center Creek Water and Irrigation Company | May 17, 1887 | 5,000 | 500 | 500 | Do. |
| Daniels Creek Irrigation Company | Apr. 22, 1887 | 1,270 | 127 | 300 | Midway. |
| Strawberry Canal Company | Mar. 26, 1888 | 3,665 | 365 | 365 | Heber. |
| Willow Creek Canal Company | Feb. 17, 1892 | 10,000 | 10,000 | 300 | Do. |

The Lake Creek Reservoir and Irrigation Company and the Center Creek Water and Irrigation Company were incorporated for the purpose of constructing and maintaining reservoirs for the storage of surplus water of Lake and Center creeks, respectively. The Strawberry Canal Company and the Willow Creek Canal Company take water from Strawberry Creek, a tributary of the Duchesne River, and carry it over the divide into the headwaters of Daniels Creek, to be used for irrigating lands in Provo Valley.

The total area irrigated from these creeks and from the reservoir water aggregates 2,700 acres, most of which lies along the several creeks and in the eastern

portion of the valley. Prior to the construction of the Wasatch Canal, which diverts water from Provo River, the water from Lake Creek was used largely in and near Heber. Since the construction of this canal Heber has been supplied from it and the water of Lake Creek not used for irrigation above has been allowed to flow into the canal and from it is distributed to the various users of water under the canal.

Snake Creek and Pine Creek enter the valley from the west. The greater portion of the water supply of Pine Creek comes from Mahogany Springs, situated near the point at which Pine Creek emerges from the mountains. Snake Creek has its source near the top of the range of mountains which separates Provo Valley from the northern extremity of Utah Lake Valley. It flows in a southeasterly direction, entering the valley about 2 miles northwest of Midway. The waters of both Snake Creek and Pine Creek are controlled by the Midway Irrigation Company. The discharge of these creeks, as measured at different times during the irrigation season of 1900, is given in the following summary:

*Discharge of creeks entering Provo Valley from the west, 1900.*

| | Cu. ft. per sec. |
|---|---|
| Snake Creek: | |
| July 9 | 17.480 |
| July 25 | 15.100 |
| August 2 | 14.690 |
| August 20 | 14.730 |
| Average for season | 15.600 |
| Pine Creek and Mahogany Springs: | |
| July 9 | 2.500 |
| July 25 | 3.220 |
| August 2 | 2.380 |
| August 20 | 2.500 |
| Average for season | 2.650 |

There are no reservoirs on these creeks, hence the flow given is the natural discharge of the creeks. Snake Creek is the largest tributary of Provo River in this valley and the one whose flow is the most constant.

## NORTH FIELD DITCH.

The first settlement in Provo Valley was made in 1858, when a colony of about 60 located in the bottom of the valley in what was afterwards called the North Field. In 1859 these settlers diverted from the south side of Provo River sufficient water for the small tracts of land on which they had settled. About 4 miles north of the present site of Heber, a channel was cut through the river bank to an abandoned river channel which had been cleared of stones and brush and made to serve as a canal. This was known as the North Field Ditch. In 1863 an additional diversion on the south side was made about a mile below the head of the ditch previously taken out. This latter ditch was termed the West Ditch. The area irrigated by these ditches continously increased until 1865, when between 2,000 and 3,000 acres of bottom land in the North Field received its water from them. Since then the irrigated area has increased but little.

About 1871 the head of the North Field Ditch was transferred upstream about half a mile. This new section of ditch is somewhat larger than the old channel and for the first half mile of its length serves as a joint canal, carrying water for the North Field Ditch, the Wasatch Canal, and the McDonald Ditch. The flow is divided between these ditches near the original head of the North Field Ditch. From the division gate the ditch extends in a southerly direction for a mile or so, where it divides into several small channels, from each of which small laterals distribute the water to the irrigated land. The discharge of the North Field Ditch is given below:

*Discharge of North Field Ditch for the season of 1900.*

| | Cu. ft. per sec. |
|---|---|
| May 26 | 50.610 |
| June 25 | 46.840 |
| July 9 | 36.750 |
| July 25 | 26.420 |
| August 2 | 19.290 |
| August 20 | 16.870 |
| September 13 | 16.270 |
| Average for season | 30.440 |

For upward of thirty years these ditches were controlled by an unincorporated association known locally as the North Field Ditch Company, and not until February 12, 1890 was the company incorporated. It has a capital stock of $40,000, divided into 4,000 shares.

## WASATCH CANAL AND M'DONALD DITCH.

From the division gates in the joint canal just mentioned the water for these two ditches flows in a joint channel for half a mile, at which point McDonald Ditch leaves Wasatch Canal and, flowing in a course parallel to it for about 2 miles, furnishes water to about 250 acres of land. The right of this ditch to the water of the river was acquired some years prior to the rights of the Wasatch Canal.

From the point at which McDonald Ditch leaves the joint canal, Wasatch Canal takes a southeasterly course and, skirting the foothills, passes a point about 1 mile east of Heber, where a considerable portion of its flow is turned from the canal, and after furnishing power for the Heber City Flouring Mills is used for irrigation of land lying below. Nearly 2 miles southwest from the mills, at its point of intersection with the channel of Center Creek, the canal terminates and the surplus water is discharged into the creek.

The construction of this canal was begun in 1871. The original canal was 3 feet in width and 1 foot in depth. Each succeeding year the channel was enlarged until it had a width of about 8 feet and a depth of 1 to 3 feet and a fall of one-fourth inch per rod, or nearly 7 feet per mile. The total length of canal is given as 6 miles, and the area irrigated 2,120 acres.

In the following summary is given the combined flow of Wasatch Canal and McDonald Ditch, as measured during the season of 1900, one-eighth mile below the point at which North Field Ditch leaves the joint canal.

*Discharge of Wasatch Canal and McDonald Ditch for season of 1900.*

| | Cu. ft. per sec. |
|---|---|
| May 25 | 85.980 |
| June 25 | 34.370 |
| July 9 | 28.750 |
| July 25 | 29.770 |
| August 2 | 21.710 |
| August 20 | 14.350 |
| September 13 | 26.230 |
| Average for season | 34.450 |

On the assumption that during the irrigation season, lasting from May 15 to September 15, inclusive, the average volume of water delivered to the land by these two canals is fairly represented by the average given in the summary, the 2,370 acres received a depth of 3½ feet.

The association of farmers which built and controlled this canal was incorporated in 1896 with a capital stock of $23,000, divided into $10 shares, each share representing sufficient water for the irrigation of 1 acre of land.

### MIDWAY CANAL.

This is a small canal that diverts water from the north side of the river, about 1½ miles below the head of the joint canal, which supplies the canals just described. It flows in a southwesterly direction for nearly 3 miles and empties into the Gurvey Ditch, which diverts water from Snake Creek. The water is used on land in the vicinity of Midway.

The canal is owned and operated by the Midway Irrigation Company, which existed many years prior to its incorporation, in 1888. The canal was constructed, in 1889, for the purpose of diverting from the river the water which seeped through the dam at the head of the joint canal. In 1894, by agreement with the Ontario Mining Company, the Midway Irrigation Company was awarded 5½ cubic feet per second of the water discharged from Ontario Drain Tunnel so long as there was that quantity of water in the river at the head gate of the canal. In order to carry this additional water, the canal was enlarged. The area of land irrigated, exclusive of that watered from the Ontario Tunnel, aggregates 300 acres.

The Midway Irrigation Company also controls the waters of Snake Creek and Pine Creek and a number of minor streams and springs rising on the west side of the valley. The Island Ditch, also controlled by this company, is taken from the Provo, about 1½ miles east of Midway. This ditch is small, and during the latter part of the irrigation season receives only seepage water that has found its way back to the river above the head of the ditch.

The average flow for the season of 1900 of the various sources of water supply under the control of the Midway Irrigation Company is given in the following summary:

*Average flow of canals and creeks controlled by Midway Irrigation Company, 1900.*

| | Cu. ft. per sec. |
|---|---|
| Midway Canal: | 22.670 |
| May 25 | 13.488 |
| June 25 | 7.310 |
| July 9 | 3.997 |
| July 25 | 3.865 |
| August 2 | 4.517 |
| August 20 | 5.390 |
| September 13 | |
| Average for season | 8.748 |
| Island Ditch: | 50.404 |
| May 26 | 7.056 |
| June 25 | 1.551 |
| July 9 | 2.251 |
| July 25 | 3.003 |
| August 2 | 0.000 |
| August 20 | 0.000 |
| September 13 | |
| Average for season | 10.711 |
| Snake Creek: Average for season | 15.500 |
| Pine Creek and Mahogany Springs: Average for season | 2.650 |

SPRING CREEK AND SAGEBRUSH DITCHES.

Lying just north of Heber is a considerable area of swampy land on which there are a number of springs. The water from this section is brought together and forms Spring Creek, which, when augmented by seepage water from the lands irrigated under the North Field Ditch and the Wasatch Canal, forms a considerable stream. This creek flows in a southwesterly direction and joins the river 1½ miles southwest of Heber. About three-fourths of a mile northwest of Heber the Spring Creek Ditch taps the creek and flows in a general southwesterly direction for a distance of 4½ miles, irrigating an area of between 400 and 500 acres. This ditch is operated by the Spring Creek Ditch Irrigation Company, incorporated in 1890. Intimately connected with this ditch and the company controlling it is the Sagebrush Ditch, controlled by the Sagebrush Irrigation Company, incorporated in 1892, to convey water from Rock Creek or the Big Slough, in the North Field, into Spring Creek during high-water season. It is seldom used after the first of July.

The flow of the Spring Creek Ditch for the season of 1900, measured at a point one-half mile west of Heber, is given in the following table:

*Discharge of Spring Creek Ditch, 1900.*

| | Cu. ft. per sec. |
|---|---|
| | 32.077 |
| May 26 | 23.428 |
| June 25 | 13.240 |
| July 25 | 14.730 |
| August 2 | 6.125 |
| August 20 | 9.648 |
| September 13 | |
| Average for season | 16.541 |

### CHARLESTON CANAL.

This canal obtains its water supply from Spring Creek and from the Phil Smith Slough, which is fed by seepage from the North Field and lands under the Wasatch Canal. The canal is controlled by the Charleston Irrigation Company, incorporated in 1888, and was constructed in 1870 and enlarged to its present size in 1878. The canal heads about 1 mile west of Heber, whence it extends in a southwesterly direction nearly 5 miles and terminates at a point 2 miles south of Charleston.

The rights of this canal are considered as secondary to the rights of both the North Field Ditch and the Wasatch Canal. When water becomes scarce, the canal is dependent on the surplus water from the North Field Ditch and the Wasatch Canal Each year for the last ten or twelve years an agreement, usually verbal, has been made with the officers of the North Field Ditch to supply the Charleston Canal, the consideration varying with the nature of the season and the amount of water available. For the last six or seven years a similar agreement has also been made with the Wasatch Canal Company. This company also controls one or two small canals which take seepage waters from the river at points a mile or so north of Charleston. The more important of these is the Lower Charleston Canal. The water diverted by these canals is used on land in the vicinity of Charleston, the total area irrigated varying between 900 and 1,000 acres. A portion of the water used in this section is drawn from Daniels Creek, which joins the river near Charleston.

*Discharge of canals controlled by Charleston Irrigation Company, 1900.*

| | Cu. ft. per sec. |
|---|---|
| Charleston Canal (Upper): | |
| May 25 | 56.445 |
| June 25 | 14.330 |
| July 25 | 14.040 |
| August 2 | 9.060 |
| August 20 | 10.050 |
| September 13 | 8.684 |
| Average for season | 18.768 |
| Charleston Canal (Lower): | |
| August 23 | 13.874 |
| September 13 | 13.450 |
| Average for season | 13.662 |

### ROUND VALLEY.

A short distance below Charleston the sides of the valley gradually close in and the river again enters a narrow canyon. A short distance above where the river leaves the valley it is joined from the southeast by Round Valley Creek, which comes from Round Valley, lying directly south of Provo Valley and separated from it by a low range of hills. This valley is a small one, containing between 2,000 and 3,000 acres of cultivated land. Its water supply is furnished largely by Hobble Creek and Main Creek, which enter the valley from the southeast and which are controlled by two incorporated companies.

There are also a number of springs rising in the bottom of the valley, the waters of which are used for irrigating considerable areas. The largest of these springs rises just south of the settlement of Wallsburg, and is known as the Town Spring.

The water of these various sources, after having been used in the upper part of the valley and finding its way again to the bottom of the valley as seepage, is diverted by other small ditches, thus serving a considerable additional area of land. At the lower end of the valley the several creek channels unite and form Round Valley Creek, which flows in a northwesterly direction and, leaving the valley by a short canyon, joins the river at the point above mentioned.

The flow of the creeks of Round Valley was measured but twice during the season, and then during the extreme low-water period, so that the results given in the following summary represent about their minimum flow as measured where they enter the valley:

*Flow of creeks of Round Valley, 1900.*

| | Cu. ft. per sec. |
|---|---|
| Hobble Creek: | |
| July 26 | 1.204 |
| August 23 | 1.958 |
| Main Creek: | |
| July 26 | 1.557 |
| August 23 | 1.913 |
| Town Spring: | |
| July 26 | 3.027 |
| August 23 | 2.954 |

The river from the point at which it is joined by Round Valley Creek follows the canyon in a general southwesterly direction until it reaches Utah Lake Valley. All along its course through the canyon it is fed by numerous tributaries, the more important of which are the North Fork and Deer Creek from the north, and South Fork, Bridal Veil Falls, and Pole Canyon Creek from the south. From these creeks, which head high up in the mountains, a generous supply of water enters the river, and with its natural flow furnishes the various canal interests along Provo River in Utah Lake Valley with an abundance the year round.

## PROVO RIVER IN UTAH LAKE VALLEY.

The section susceptible of irrigation from the Provo in Utah Lake Valley lies between the lake on the west and the foothills which form the eastern rim of the valley on the east. It extends northward almost to the town of Pleasant Grove and southward to a point 3 or 4 miles south of Provo. The area within these limits approximates 30,000 acres, 18,000 acres of which is a liberal estimate of the area entitled to water from the Provo and which could be irrigated if the water supply of the river were properly controlled. The remaining 12,000 acres are located along the shores of the lake and are of a marshy nature, being saturated by seepage from the irrigated lands above. This land is too wet for cultivation and is used only for meadows and pasture. The irrigable section consists largely of bench lands lying on either side of the river and bottom lands lying along the river's course.

At the point where the river enters the valley it has cut its way down through the stepped benches which at different times formed the shore lines of Lake Bonneville, and has made for itself a channel which gradually increases in width as it leaves the mouth of the canyon, until, at the point where the benches terminate, the river bottoms have a width of a mile or more. The soil in these river bottoms is an extremely fertile alluvial deposit. The soil on the bench land, as previously stated, is also fer-

tile, but is of less depth and more gravelly than the bottom lands, and has a porous gravelly subsoil which insures good drainage.

The river, after leaving the mouth of the canyon, flows in a southerly direction until it nearly reaches the northern limit of Provo City, then turns in a westerly direction and flows toward the lake, entering it 3 miles due west of Provo City.

The canals which divert water below the mouth of the canyon are developed from the ditches that were taken from the river by settlers who came into the valley in the early days. Those small, crooked ditches have from time to time been enlarged, their courses straightened, and, in many instances, the points of diversion changed.

In describing the several canals those heading on the west side of the river will be taken up first, those heading on the east side being considered afterwards. In both cases the canals will be considered as they head on the river, beginning with the highest canal on either side and continuing downstream.

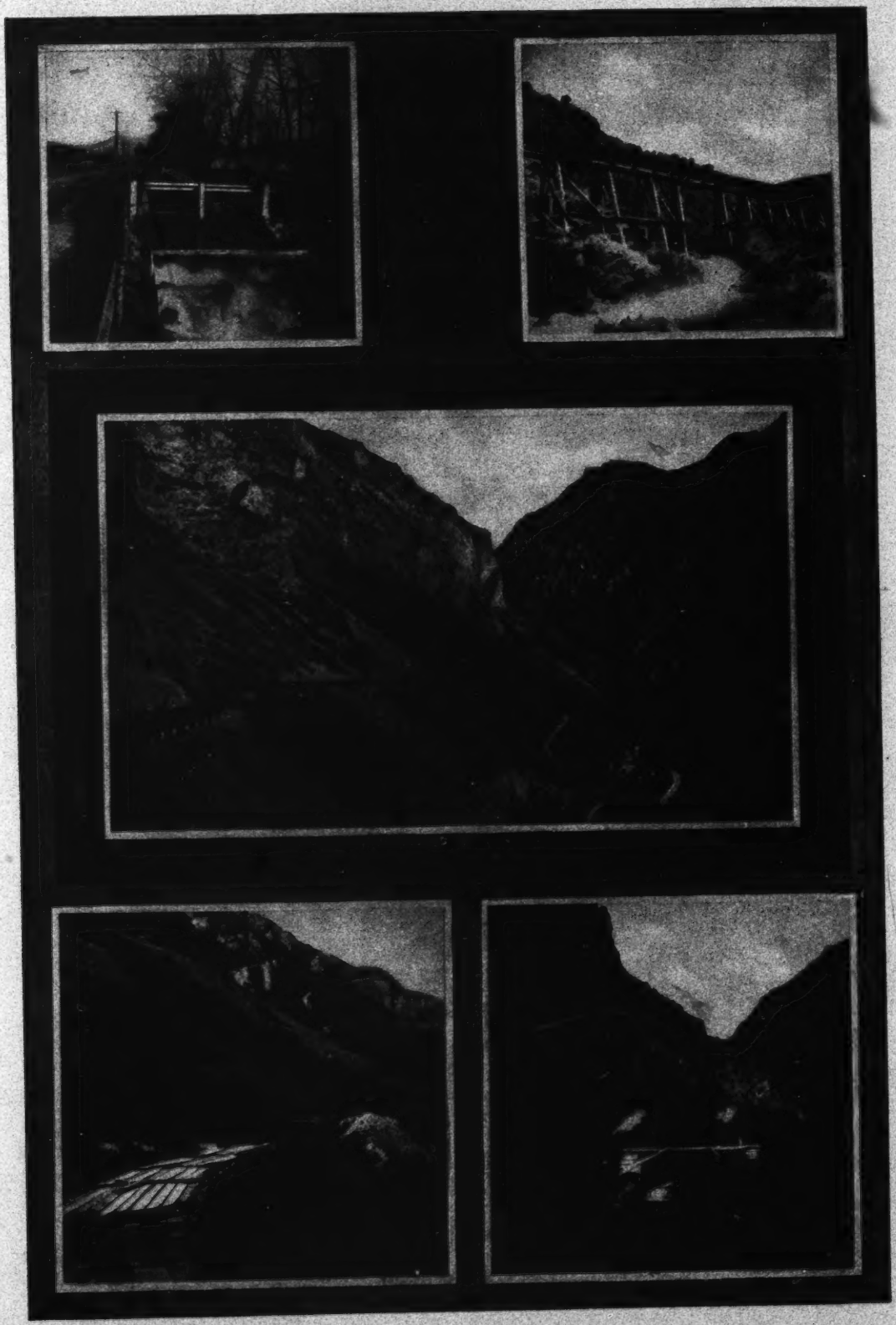
### TELLURIDE POWER TRANSMISSION COMPANY.

Of the several canals heading on the west side of the river, all but one are irrigation canals and are owned and operated by the farmers owning land under them. This one exception is the diversion made by the Telluride Power Transmission Company. This company takes water from the river about 5 miles above the mouth of the canyon near where Pole Canyon Creek enters the river. The water is diverted by means of a timber dam, which raises the water about 10 feet above the bed of the river. From the dam the water is carried along the west side of the canyon in a wooden stave flume of semielliptical form (Pl. VII) for about a mile, and is conveyed to the power house by two 4-foot wooden stave pipes. The electricity there generated is transmitted at a high voltage to various points in Utah Valley and the Tintic mining district lying to the west, where it is used for power, heat, and lighting purposes. It is the plan of this company to eventually continue the present flume line on to a point a short distance above the mouth of the canyon, at which point a more permanent and much larger plant will be installed. The present temporary plant was constructed for the purpose of developing a market for the power. This company is entitled to the entire flow of the river for power purposes, but the water is turned back into the river above the head gates of all the canals but one, and little or no inconvenience is caused by the use of the water for power.

### ALTA DITCH.

This ditch derives its supply from Guard Quarter Springs, which rise on the west side of the canyon about 3 miles above its mouth. These springs come out at an elevation between 200 and 300 feet above the bottom of the canyon and the water discharged by them is caught by the ditch which skirts the sides of the canyon and enters the valley about a quarter of a mile northwest of the mouth of the canyon. At this point the water is conveyed down a rocky ravine to the level of the bench lands. From this level the ditch takes a northwesterly course for 2 miles, watering 300 acres, most of which is set to orchards.

The ditch was commenced in 1875. It is not more than 3 feet wide and 1 foot deep. The average flow for the season of 1900 was about 4 cubic feet per second. It is controlled by the Alta Ditch and Canal Company, incorporated in 1898.



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DAM, HEAD OF POWER PLANT, PROVO RIVER.

HEADGATE AND DAM, WILSON CANAL, WEBER RIVER, UTAH.

DAM, HEAD OF TIMPANOGOS CANAL, PROVO RIVER.

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### BLUE CLIFF CANAL.

In 1885 a community of farmers living on Provo Bench, between the mouth of Provo Canyon and Pleasant Grove, formed the Blue Cliff Canal Company for the purpose of constructing and controlling this canal. Work was begun in 1885, but owing to the rough nature of the land over which the line runs and to difficulties in construction, no water was turned into the canal until 1901. From the point where the canal heads, about 2½ miles above the mouth of the canyon, it skirts the west side of the canyon and emerges on to Provo Bench a short distance below the Alta Ditch. Nothing has been done toward the construction of the canal beyond this point, so that until the portion of the line which follows the contour of the upper benches is constructed there will be no irrigation under this canal.

The right of this company to the water they intend to divert is secondary and entitles them to water during the high-water season only. It is the intention, however, to construct a reservoir on the bench having a capacity of 8,712,000 cubic feet, which will be used to augment the supply of water received from other sources.

### PROVO BENCH CANAL.

This canal heads in the mouth of the canyon and takes a southwesterly course, gaining the top of Provo Bench at a distance of nearly 2 miles from the head. The average width of the canal throughout this distance is between 12 and 15 feet, and its average fall 10 feet per mile.

From the head to the point at which the canal gains the top of the bench it carries, in addition to the water used on Provo Bench, the supply for North Union Canal, owned and operated by a separate corporation. This canal leaves the main canal soon after it reaches the top of the bench and extends to Pleasant Grove, where the greater part of its flow is used for irrigation. The other portion of water delivered at the division box is distributed by several ditches and small laterals to the greater area of Provo Bench.

The area irrigated under this canal, including that watered from the North Union Canal, approximates 4,000 acres, while the area that could be irrigated were water available is very much in excess of this. The construction of this canal was begun in 1862, but owing to the nature of the country and to disagreements among the promoters of the enterprise it was not finished until 1864. The original plan was that the towns of Lehi, American Fork, and Pleasant Grove, which had previously appropriated American Fork Creek, should join with the settlers on Provo Bench in the construction of the canal which, when constructed, was to supply Pleasant Grove district with water. That district, when thus supplied with water, was to relinquish its right to the waters of American Fork Creek in favor of Lehi and American Fork. For various reasons this scheme failed, and a majority of the stock owned by parties in Lehi and American Fork was bought up by other settlers on Provo Bench, who completed the canal and applied the water to their lands. The settlers of Pleasant Grove, however, retained their stock in the canal, and constructed the North Union Canal to convey the water to their land. In 1876 the company was incorporated under the name of the Provo Bench Canal and Irrigation Company, with a capital stock of $45,600.

### WEST UNION CANAL.

This canal takes its water from the river about one-half mile below the head gate of Provo Bench Canal, follows the river bottoms for nearly 3½ miles, and after reaching the Lower Provo Bench passes around the foot of the high bench and takes a northwesterly course for 4 miles, thence turning west toward the lake. The total length of the main canal is a little over 10 miles. Little or no land is irrigated under the canal for the first 2 miles, the land under that section receiving its water supply from other sources. The total area irrigated is given at 3,500 acres.

Since March, 1897, the canal has been operated and controlled by the West Union Canal Company, which was formed at that time by the union of the Enterprise Canal Company and the Union Canal Company. Each company previous to their union controlled a separate system. The Union or Hooper Canal, as it was known, headed at the present point of diversion, while the head of the Enterprise Canal was about 2 miles below. A considerable number of stockholders in one company were stockholders in the other, and it was thought best to unite the interests of the two canals and thus materially decrease the expense of maintenance and simplify the management. With this end in view the West Union Canal Company was incorporated, with a capital stock of $40,000.

The main portion of the Enterprise Canal was abandoned and the main canal of the Union system was enlarged and improved. The construction of the Enterprise and Union canals was begun in 1872, but water was not diverted by them until 1876. The rights to the water as acquired at this time are considered as primary and among the earlier rights on the stream.

### LAKE BOTTOM CANAL.

This canal is the lowest one diverting water from the west side of Provo River. Its head gate is located about 3 miles below the head of the West Union Canal. The water is conveyed in a roughly constructed channel along the river bottoms for nearly 2 miles, where a more carefully constructed canal begins. From this point the canal takes a northwesterly direction in a course parallel to the West Union Canal. The total length of the canal, including its seminatural channel in the river bottoms, is between 7 and 8 miles. The area of land entitled to water under the system approximates 6,000 acres.

This canal has one of the earliest water rights on the river. The first appropriation was made in 1856 or 1857, at which time only a small ditch was taken out and but little water used. The canal was afterwards enlarged and the amount of water taken out increased. In addition to the supply of river water to which this canal is entitled, it is by virtue of its location able to control a great part of the seepage and return water from the Provo Bench above, which comes to the surface in small springs along the river bottoms and along the foot of Provo Bench. This water is caught by the canal, and during the greater part of the irrigation season is of sufficient amount to satisfy the needs of all the irrigated land under it. For several years the company controlling the canal has depended on this means for supplying its canal and has allowed its share of the river water to be divided proportionately among the several canals lying higher up on the river. It is understood, however,

among the several companies that the Lake Bottom Company has in no way relinquished its right to water from the river, and that if at any time the seepage water should fail they can claim their supply direct from the river.

The canals described are, with the exception of a few individual ditches which divert water from the river along the river bottoms, the only canals taking water from the west side of the river.

### SMITH DITCH.

The Smith Ditch is the highest on the east side of the river. This ditch, however, like the Alta Ditch, does not draw its supply direct from the river, but is supplied from several small springs about 3 miles above the mouth of the canyon. The ditch follows the side of the canyon to its mouth, whence it is carried to the East Provo Bench, directly south of the mouth of the canyon. The ditch is of small dimensions and was built on no regular grade. The area irrigated varies with different years, between 40 and 50 acres. The ditch was constructed in 1887 by the appropriators on whose land the water is used. Their right to water, acquired in 1883, is considered as primary and has never been disputed.

### TIMPANOGAS CANAL.

This canal is taken from the river at the mouth of the canyon, and but a short distance below the head gate of the Provo Bench Canal on the opposite side of the river. From its head gate the canal, which has an average width of about 8 feet, is carried on an even grade along the steep slope between the bench and the river bottoms, and gains the top of the bench a little more than 1½ miles below the head gate. From the top of the bench the canal flows in a southeasterly direction for nearly a mile, then following close to the foothills, which rise abruptly from the higher levels of the bench, terminates about a mile northeast of Provo. The total length of the canal is 4½ miles. The irrigated area under the canal lies on Pole Canyon and Rock Canyon benches, which are a continuation of the Provo Bench on the other side of the river, and approximate 650 acres. Of this amount, however, only about 500 acres are regularly irrigated.

The company which controls this canal was incorporated in 1878 under the name of the Timpanogas Irrigation Company, with a capital stock of $4,125, divided into $25 shares. The shareholders, all of whom were farmers, immediately after the formation of this company began the construction of the canal, and in 1882 finished it as it exists to-day. Their right to water is considered as primary.

### CITY CREEK.

Immediately below the head of the Timpanogas Canal, City Creek diverts a portion of the river. This creek is really an old channel of the river that has been straightened and cleaned out and is utilized as an auxiliary channel from which a majority of the canals on the east side of the river derive their supply. From its head the creek traverses the river bottoms parallel to the river for nearly 4 miles, and enters the river 1 mile north of Provo. Although no land is irrigated directly from this creek, it is an important factor in the distribution of water on the east side of the river.

### UPPER EAST UNION CANAL.

This is the second canal in elevation taking water from the east side of the river. It heads on City Creek one-half mile below the head of the Timpanogas Canal. From this point it follows the river bottoms in a roughly constructed channel for nearly 2 miles, whence it leaves the river bottoms and, bearing to the southeast, skirts the foothills on the east side of the valley, and finally terminates about 3 miles southeast of Provo. The total length of the canal is between 7 and 8 miles. The area irrigated aggregates 713 acres.

The company which controls the canal was organized in 1870, and was incorporated in 1884 with a capital stock of $17,220. The company at once began the construction of the canal and finished it in 1876. Water was first diverted in 1871; since that time the canal has been somewhat changed and the amount of water diverted increased.

Associated with the Upper East Union Canal Company is an unincorporated company known as the Fausett Ditch Company. This company uses a portion of the main canal jointly with the Upper East Union Company.

### CANALS CONTROLLED BY PROVO CITY.

Of the five other canals which draw their supply of water from the east side of the river, four—the East Union, Factory Race, City Race, and Tanners Race canals—are controlled by Provo City. The first of these canals is used exclusively for irrigation purposes. It derives its supply from City Creek about 1¼ miles north of Provo City. From there it takes a southeasterly course and running parallel with the Upper East Union Canal terminates 2½ miles southeast of the city. The other three canals, in addition to being used for power purposes, also serve a considerable area of land. The Factory Race, the largest of these three canals, is taken from City Creek a short distance below the East Union Canal. From its head it flows directly south and enters Provo City near the center of its northern boundary, and in addition to supplying a considerable portion of the city with water for irrigation purposes, furnishes power for four separate mills within the city limits. From the tailrace of the lowest mill, which is situated in the south edge of the city, the canal flows in a southerly direction and enters the lake 2 miles south of the city. Below the city there is comparatively little land irrigated, so that so far as irrigation purposes are concerned the greater part of the flow of the Factory Race is unavailable. During the last few years, however, the flow in this race during nights, Sundays, and holidays, and for the greater portion of each week during the period of shortest supply, has been cut off and used for irrigation.

The City Race also derives its supply from City Creek, and but a short distance below the head of Factory Race, when it flows south and passes through the city on a course parallel to Factory Race and about one-fourth of a mile below it. The water used for power from this race is available for irrigation below, so that the power interests on the race are in no way a hindrance to the irrigation interests. The area irrigated under this race is estimated at 380 acres, a considerable portion of which lies southwest of the city.

Tanners Race, the fourth canal mentioned as under the control of Provo City, derives its water supply from the river direct, at a point in the northwest part of the

city. From its head the race flows in a general southwesterly direction and furnishes an aggregate area of 500 acres with water.

The rights of these four canals just described are among the earliest rights on the river, having been acquired in 1856 and 1857. In 1874, owing to the interests of the four canals being so closely related, and in order to better control the water supply which the several ditches diverted, Provo City, by agreement, was placed in control of the canals.

Provo City controls also the source of the municipal water supply. The intake of the system is located near the head of the Upper East Union Canal, about 5½ miles north of the city. From the settling basin there located the water is conveyed to the city through a 2-foot wooden-stave pipe. The amount of water to which the city is entitled from this source is conceded to be 500 cubic feet per minute, or 8.33 cubic feet per second. The right of the city to this amount of water from the river has never been questioned.

### LITTLE DRY CREEK CANAL.

This canal is the lowest on the river. It diverts its supply direct from the river one-fourth mile below the head of Tanners Race, thence running in a southwesterly direction, it furnishes water to land west of Provo City. The right of this canal is probably the oldest of any of the existing rights on the stream. The canal was constructed and water first diverted in 1850 by some of the first settlers that came into the valley from Salt Lake Valley.

The company which at present controls Little Dry Creek was incorporated in 1892 with a capital stock of $16,000, divided into 400 shares, each share entitling the holder to sufficient water for 1 acre of land. The area irrigated is given as 440 acres.

### RIVER-BOTTOM DITCHES.

In addition to the larger canal systems just described, there are a number of small individual ditches that take their supply of water direct from the river and are used for irrigating the greater portion of the river bottoms. These ditches, some nine in number, head both on City Creek and on the river and are scattered along the bottoms from the mouth of the canyon to the head of Lake Bottom Canal. The total area irrigated is estimated at 900 acres, 700 acres being located on the east side of the river and 200 acres on the west.

## USE OF WATER UNDER PROVO RIVER CANALS IN UTAH LAKE VALLEY.

The object of the series of measurements in the drainage basin of Utah Lake made during the irrigation season of 1900 was to determine, in a general way, the average discharge of the natural streams and also the nature and extent of the diversions made from them for irrigation. The results obtained were naturally of a general nature, for under the circumstances the size of the drainage basin precluded a detailed investigation on all the streams and their connected canal systems. Special attention was directed to the canals on the Provo in Utah Lake Valley, and the conditions on them were taken up in detail. The results obtained and the conclusions that may be drawn from their examination may be taken as fairly representative of the conditions existing in other sections of the basin.

This study was begun in the latter part of March, when rating stations were established on all the large canals and arrangements made whereby an accurate record of the discharge of each canal during the entire irrigation season could be obtained. The gauge heights from which the discharge of the river above all the canals were obtained were kindly furnished by the United States Geological Survey. The reading of the river gauge, however, was not begun until the latter part of May. The supply in the river prior to this time had been more than sufficient for all the canals, a considerable portion of the river's supply flowing unused into the lake.

### APPORTIONMENT OF WATER.

The basis of apportionment used during the season of 1900 was one that had been recommended the year previous by a committee appointed to investigate the rights of the several canals. This apportionment was not satisfactory to all the interests, but in lieu of a better adjustment was used during the season until a more satisfactory apportionment could be arranged. By this schedule none of the canals receives a fixed volume of water, but whatever supply the river furnishes is distributed pro rata among the several canals according to their respective rights. When the discharge of the river exceeds 18,000 cubic feet per minute, there is an abundance of water for the needs of all the canals. When, however, the flow of the river diminishes to 18,000 cubic feet per minute, it is necessary to apportion the stream. The apportionment then made remains constant until the river's flow decreases to 15,000 cubic feet per minute, when the flow in the several canals is readjusted and the proportion of the stream to which each is entitled is changed, such change being made necessary by the variation in the nature of the water rights of the several canals. When the river reaches the 12,000 cubic feet per minute stage the flow of the canals is adjusted the second time, which adjustment remains constant down to the lowest stage of the river. In the following table is given the schedule of apportionment used in 1900:

*Schedule of pro rata distribution of the water among Provo River canals.*

| Name of canal. | Between 18,000 and 15,000 cubic feet per minute. | Between 15,000 and 12,000 cubic feet per minute. | Between 12,000 cubic feet per minute and lowest stage of river. |
|---|---|---|---|
| Lake Bottom Canal | 0.050 | 0.055 | 0.060 |
| West Union Canal | .118 | .119 | .120 |
| Provo Bench Canal | .230 | .177 | .1475 |
| Timpanogas Canal | .040 | .036 | .030 |
| Upper East Union Canal | .061 | .067 | .072 |
| Canals under control of Provo City | 353 | .390 | .410 |
| Little Dry Creek Ditch | .033 | .040 | .045 |
| River-bottom ditches | .090 | .090 | .090 |
| Fausetts Field Ditch | .017 | .018 | .0185 |
| Carter & Tanner Ditch | .008 | .008 | .007 |

Those canals which enjoy the earlier rights receive a less proportion than other canals during the high stage of the river, and have their proportion increased as the season advances, while the proportion drawn by those canals having later rights is decreased as the flow of the river diminishes.

At the beginning of the irrigation season of 1900 the representatives of the Provo canals appointed a water commissioner, Mr. T. E. Thurman, who, with the water masters of the several systems, attended to the apportionment of the river's supply during the season. The measurements of the flow in the various canals were made by means of rectangular weirs placed as near as practicable to the points at which water is first used. The majority of the weirs used were of rough construction and in their use little or no attention was paid to the velocity with which the water approached the crest of the weir. The results obtained under such conditions were naturally somewhat in error. They were, however, close approximations to the actual flow of the canals. The inauguration of this system of measurement is a step in the right direction and shows an inclination on the part of the several canal interests to adjust their difficulties by means acceptable and satisfactory to all parties interested. If other canal organizations in the system would exercise the same ingenuity in the division of the streams in which they are interested, the greater part of the trouble and litigation over water rights now prevalent in the section under discussion would be done away with.

In making an apportionment of the river's supply the water commissioner, in company with the several water masters, measures the flow in all the canals and ditches entitled to water and takes the aggregate amount carried by the canals as the flow of the river, and upon this as a basis the share of each canal is determined. A second trip over the system is then made, and each canal is given its proper volume of water. By this means the problem of allowing for seepage and return water is easily solved.

It would seem that after the flow of the river was once correctly apportioned among the several canals, no further adjustment would be required until the river fell to the stage below, when a new apportionment would be made necessary. This, however, is not the case, for owing to the nature of the temporary dams used for diverting the water, constant attention is required to prevent one canal from obtaining more than its share.

On account of the small supply furnished by the river during the season of 1900 it was found necessary to make an apportionment as early as June 18, at which time the flow of the river had fallen almost to 12,000 cubic feet per minute. From that time on it was found necessary to adjust the flow about every ten days.

### DISTRIBUTION OF WATER.

The method employed in distributing the water from the different canals is very much the same throughout the system. From the main canals the water is conveyed to the irrigated lands by small channels that tap the canals at frequent intervals and are variously known as laterals, ditches, or sects. Many of these smaller distributing channels have been constructed and are controlled by organizations separate and apart from the company controlling the canal system, and these organizations are interested in the main system only so far as they are dependent on it for their water supply. The laterals or ditches that are not under the supervision of separate organizations are considered a part of the main system and are controlled as such.

The water is distributed from the canals and laterals by an officer known as a water master, whose duties, in addition to attending to the distribution of the water

from the main canal, consist in keeping the canal channel and all structures connected with the system in repair, and, in company with the water commissioner and the water masters of the several canals of the system, in attending to the apportionment of the river's supply among the canals. The amount of water turned into a lateral is usually not measured, but estimated by the water master on the basis of the acreage entitled to water under such lateral. The unit of measurement in use is called an "irrigation stream." This is the amount of water one man can handle in irrigating a crop and represents no fixed volume, owing to the varying conditions under which it is used. Several measurements made showed that irrigation streams varied from one-half cubic foot per second to 2 and sometimes 3 cubic feet per second.

As a rule the water is distributed to the irrigators from the laterals on the time basis, allowing each irrigator the use of one or more irrigation streams, according to his facilities for handling them, for a period proportionate to his interest in the canal, which, as a rule, is in direct proportion to the area of his irrigated land. At the beginning of the irrigation season the water master prepares a schedule for each lateral, giving the order of rotation among the several irrigators under the lateral the time to a minute at which each one in his turn is to begin irrigating, and the time his period of use ends. This method of using water by turns has been in practice under the majority of the canals for several years, and has proved a very satisfactory and economical system of distribution.

### METHODS OF IRRIGATION.

In the early history of this system the lands were overwatered, it being thought necessary by the settlers that the land should be flooded for a long time in order to produce a crop. Continued experience has, however, proved that abundant crops can be raised on the same land by the use of less water.

At the present time the irrigation of such crops as hay and small grain is accomplished by a so-called method of flooding, which consists in spreading the water over the surface of the field by small furrows or channels made with a home-made implement known as a "marker." The furrows made by this marker are 3 or 4 inches in width by 2 inches in depth and are spaced from 1 to 2 feet apart. The water is not confined to these small channels, but they simply guide it to all parts of the field, insuring a thorough and effective watering of the crop. Such crops as potatoes, sugar beets, corn, fruit, and all others planted in rows, are irrigated by the furrow method.

### DUTY OF WATER UNDER PROVO RIVER CANALS.

At the beginning of the irrigation season rating stations were established on all the large canals from Provo River, and arrangements were made for obtaining frequent readings of the gauges. In the majority of the canals the sections chosen for rating stations were subject to very little change, and on these very good records of discharge were obtained. In West Union and Lake Bottom canals, however, an excessive growth of horsetail moss so seriously affected the flow near the rating station as to render the observations of little value.

The observations relative to the duty of water began on April 1 and ended on September 20, covering the entire irrigation season of one hundred and seventy-three days.

PROVO BENCH CANAL.

The rating station on Provo Bench Canal was located at a point about 1½ miles below its head and just above the point at which the North Union Canal leaves the main canal, so that the record of the flow of the canal at this point includes that used under North Union Canal. The total area irrigated during the season as estimated by the water master of the system was 4,000 acres. Some years this area is increased to 4,500 acres, but owing to the short supply of water available the irrigated area decreased to the figure given above.

The following table gives the duty of water under the Provo Bench Canal for the season of 1900:

*Duty of water under Provo Bench Canal.*

| Month. | Discharge. | | Area. | Area served per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | Cu. ft. per sec. | Acre-feet. | Acres. | Acres. | Feet. |
| April | 46.09 | 2,595.151 | 4,000 | 86.67 | 0.643 |
| May | 88.19 | 5,422.520 | 4,000 | 45.35 | 1.356 |
| June | 70.90 | 4,278.485 | 4,000 | 56.42 | 1.070 |
| July | 25.57 | 1,572.534 | 4,000 | 156.43 | .393 |
| August | 26.75 | 1,664.361 | 4,000 | 149.52 | .416 |
| September (20 days) | 27.81 | 1,103.130 | 4,000 | 143.83 | .276 |
| Total | 43.48 | 16,634.681 | 4,000 | 92.51 | 4.159 |

TIMPANOGAS CANAL.

The measuring station on Timpanogas Canal was located about 100 yards below the head gate. A flume in the canal at this point was used as a rating flume and served admirably. The area entitled to water under this canal approximates 600 acres. Of this amount, however, only 450 acres were watered during the season of 1900. The following statistics were kindly furnished by the water master of this canal:

*Acreage of crops grown and number of times each was irrigated.*

| Crop. | Acreage. | Number of times irrigated. |
|---|---|---|
| | Acres. | |
| Grain | 100 | 4 |
| Alfalfa | 150 | 5 or more. |
| Potatoes | 40 | 7 |
| Corn | 30 | 6 |
| Sugar beets | 50 | 9 |
| Orchard | 60 | 10 |
| Garden | 10 | 18 |

The following table gives the discharge of Timpanogas Canal for the season and the figures relative to the duty of water on the land served by it:

*Duty of water under Timpanogas Canal.*

| Month. | Discharge. | | Area. | Area served per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Acre-feet.* | *Acres.* | *Acres.* | *Feet.* |
| April | 13.25 | 788.175 | 450 | 33.96 | 1.75 |
| May | 18.25 | 1,122.451 | 450 | 24.65 | 2.48 |
| June | 18.36 | 1,092.188 | 450 | 24.29 | 2.42 |
| July | 8.19 | 503.803 | 450 | 54.94 | 1.12 |
| August | 9.02 | 554.083 | 450 | 49.86 | 1.23 |
| September (20 days) | 10.61 | 421.090 | 450 | 42.40 | .94 |
| Total | 13.05 | 4,481.790 | 450 | 34.48 | 9.95 |

ROBERTS DITCH.

The Roberts Ditch is the highest of the river-bottom ditches. It heads on the west side of the river, a short distance below the head of Provo Bench Canal, and flows in a southerly direction about one-fourth of a mile. The entire flow of the ditch was used on 55 acres of alfalfa located near the bank of the river and on a very loose, gravelly soil. The observations of the flow were not begun until May 23, prior to which date the water had been flowing in the ditch for some time. The results given in the following table are, therefore, incomplete, but it is still a valuable record, because it shows how large an amount of water is sometimes used:

*Duty of water under Roberts Ditch.*

| Month. | Discharge. | | Area. | Area served per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Acre-feet.* | *Acres.* | *Acres.* | *Feet.* |
| May (9 days) | 6.39 | 114.001 | 55 | 8.61 | 2.07 |
| June | 3.38 | 200.949 | 55 | 16.27 | 3.65 |
| July | 2.27 | 138.982 | 55 | 24.23 | 2.53 |
| August | 2.21 | 136.707 | 55 | 24.88 | 2.49 |
| September (20 days) | 2.35 | 93.220 | 55 | 23.40 | 1.69 |
| Total | 2.84 | 683.859 | 55 | 19.36 | 12.43 |

PARKS & ROBERTS DITCH.

The Parks & Roberts Ditch is another of the river-bottom ditches, and is the largest of this class. It takes its water direct from the river at the same point as the West Union Canal; thence, following just above this canal for a short distance, crosses it in a small flume, and delivers its supply to land lying at a distance of about half a mile from the head of the ditch. The area irrigated during the season of 1900 was devoted entirely to alfalfa and approximated 75 acres. The amount of land entitled to water from this ditch is estimated at 100 acres.

*Duty of water under Parks & Roberts Ditch.*

| Month. | Discharge. | | Area. | Area served per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Acre-feet.* | *Acres.* | *Acres.* | *Feet.* |
| April | 8.900 | 529.548 | 75 | 8.43 | 7.06 |
| May | 19.820 | 1,214.611 | 75 | 3.78 | 16.19 |
| June | 12.678 | 754.269 | 75 | 5.97 | 10.06 |
| July | 14.205 | 256.533 | 75 | 17.82 | 3.45 |
| August | 3.997 | 245.914 | 75 | 18.76 | 3.28 |
| September (20 days) | 3.810 | 151.112 | 75 | 19.68 | 2.02 |
| Total | 9.203 | 3,154.077 | 75 | 8.149 | 42.06 |

The use of water under this ditch was exceedingly wasteful. At least ten or twelve times the water needed was used. True, the soil is extremely porous, retaining but a very small part of the water applied and allowing the greater part to flow directly back into the river's channel. Whether this excessive use should be tolerated is a matter which demands attention.

UPPER EAST UNION CANAL.

The rating station on the Upper East Union Canal was located a little over a mile below the head. It was found that the section remained practically constant during the season, and that the flow of the canal for a given gauge height was the same throughout the period of observation. The area of land irrigated during the season was estimated at 713 acres. The crops grown on this land are in general the same as those grown under the canals previously considered. Following are the results of the observations made on this canal:

*Duty of water under Upper East Union Canal.*

| Month. | Discharge. | | Area. | Area served per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Acre-feet.* | *Acres.* | *Acres.* | *Feet.* |
| April | 16.52 | 983.009 | 713 | 43.15 | 1.38 |
| May | 26.00 | 1,598.601 | 713 | 27.42 | 2.24 |
| June | 26.19 | 1,558.402 | 713 | 27.22 | 2.18 |
| July | 18.76 | 1,153.136 | 713 | 38.01 | 1.62 |
| August | 15.86 | 975.580 | 713 | 44.95 | 1.36 |
| September (20 days) | 12.63 | 501.208 | 713 | 56.45 | .70 |
| Total | 19.15 | 6,769.936 | 713 | 37.23 | 9.48 |

EAST UNION CANAL.

On the East Union Canal the rating station was placed about 100 yards below the head gate. The section chosen in this canal was in firm earth, and during the entire season was subject to very little variation. The area irrigated under the canal during the season was 1,200 acres, nearly half of which was city lots located in the

eastern part of Provo City. The discharge of this canal for the season is given in the following table:

*Duty of water under East Union Canal.*

| Month. | Discharge. | | Area. | Area served per cubic foot per second. | Depth on land. |
|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Acre-feet.* | *Acres.* | *Acres.* | *Feet.* |
| April | 12.34 | 734.223 | 1,200 | 97.24 | 0.61 |
| May | 25.68 | 1,578.758 | 1,200 | 46.72 | 1.32 |
| June | 28.02 | 1,669.175 | 1,200 | 43.18 | 1.39 |
| July | 20.11 | 1,236.690 | 1,200 | 59.67 | 1.03 |
| August | 21.16 | 1,301.286 | 1,200 | 58.75 | 1.06 |
| September (20 days) | 21.62 | 857.610 | 1,200 | 55.50 | .71 |
| Total | 21.49 | 7,377.745 | 1,200 | 55.83 | 6.14 |

WEST UNION AND LAKE BOTTOM CANALS.

The flow of both the West Union Canal and the Lake Bottom Canal was so obstructed by the growth of moss in the channel near the measuring station as to make gauge readings useless. From measurements made at different times during the season, their average flow was obtained and a rough approximation of the duty of water derived. The following table gives the measured discharge of these two canals and their approximate average flow for the season, also the measurements made on the Factory Race, City Race, Tanners Race, and Little Dry Creek Canal:

*Discharge of six Provo River canals, season 1900.*

| Date. | West Union Canal. | Lake Bottom Canal. | Factory Race. | City Race. | Tanners Race. | Little Dry Creek Canal. |
|---|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* |
| May 17 | ..... | 16.65 | ..... | ..... | ..... | ..... |
| May 25 | 55.27 | 14.41 | 53.20 | ..... | 12 | ..... |
| June 2 | ..... | 11.40 | ..... | 28 | ..... | ..... |
| June 14 | 29.50 | 9.62 | ..... | ..... | 10.17 | 17 |
| June 19 | ..... | 10.51 | ..... | ..... | ..... | ..... |
| July 23 | 20.66 | 8.22 | a.75 | 16.04 | 6.49 | 10.80 |
| August 6 | 26.09 | 6.09 | ..... | ..... | 6.43 | 7.04 |
| August 24 | 22.85 | 7.89 | a1 | 16.25 | 8.24 | 7.39 |
| September 20 | 23.49 | ..... | 47.20 | a1.50 | a1.08 | 4.34 |
| Average for season | 29.64 | 10.40 | 25.53 | 15.45 | 7.40 | 9.31 |

a These measurements were made at times when the flow of the several races was being used by other canals for irrigation.

The water master estimated that the area served by the West Union Canal was 2,180 acres. Assuming that the flow of 29.64 cubic feet per second, given above, fairly represents the average for the season, the area served by each cubic foot per second of flow was approximately 74 acres, and the total depth of water applied was 4.32 feet. The Lake Bottom Canal irrigated approximately 1,000 acres of land; the area served by each cubic foot per second was 106 acres and depth of water applied to the land was 3.64 feet.

The preceding statements relative to the duty of water are summarized in the table following. The table also includes a statement of the duty of water under the Lake Bottom Canal, the West Union Canal, and the Roberts Ditch, as estimated from the incomplete record obtained on these canals.

*Summary of results relative to duty of water from Provo River.*

| Name of canal. | Discharge. | | Area. | Area served per cubic foot per second. | Depth of water applied to land. |
|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Acre-feet.* | *Acres.* | *Acres.* | *Feet.* |
| Provo Bench Canal | 48.45 | 16,634.68 | 4,000 | 82.51 | 4.16 |
| East Union Canal | 21.49 | 7,377.75 | 1,200 | 55.83 | 6.14 |
| Upper East Union Canal | 19.15 | 6,769.94 | 713 | 37.23 | 9.48 |
| Timpanogas Canal | 13.05 | 4,481.79 | 450 | 34.48 | 9.95 |
| Parks and Roberts Ditch | 9.20 | 3,154.08 | 75 | 8.15 | 42.06 |
| Lake Bottom Canal | 10.60 | ..... | 1,060 | 106 | 3.64 |
| West Union Canal | 29.64 | ..... | 2,180 | 74 | 4.32 |
| Roberts Ditch | 2.84 | 683.86 | 55 | 19.36 | 12.43 |

The following table shows the average monthly discharge of Provo River in 1900, where it enters Utah Lake Valley:

*Discharge of Provo River, season 1900.*

| | Acre-feet. |
|---|---|
| May | 23,394.2 |
| June | 26,911 |
| July | 12,556.2 |
| August | 11,261.1 |
| September | 11,703.6 |
| October | 15,450 |

By a comparison of the total flow for the various months as given in the above table with the flow during the six preceding years, taken from observations made by the United States Geological Survey, an idea of the variation in the volume of water furnished by the river in the different years may be obtained.

*Table showing monthly discharge of Provo River.*

| Year. | April. | May. | June. | July. | August. | September. | Total. |
|---|---|---|---|---|---|---|---|
| | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* |
| 1895 (2 months) | ..... | ..... | ..... | ..... | 8,917 | 8,925 | 17,842 |
| 1896 (5 months) | 49,980 | 118,450 | 70,448 | 19,311 | 15,496 | ..... | 273,687 |
| 1896 (6 months) | 37,428 | 71,694 | 97,207 | 23,611 | 19,122 | 18,387 | 267,449 |
| 1897 (6 months) | 50,985 | 114,122 | 47,365 | 18,139 | 13,835 | 15,471 | 259,867 |
| 1898 (6 months) | 33,679 | 58,844 | 48,972 | 12,421 | 9,961 | 9,987 | 173,814 |
| 1899 (6 months) | 51,092 | 71,840 | 143,860 | 66,450 | 32,925 | 30,366 | 395,033 |
| 1900 (5 months) | ..... | 23,394 | 26,911 | 12,556 | 11,261 | 11,704 | 85,826 |

## CONDITIONS AFFECTING THE DUTY OF WATER.

The object in taking up the conditions which affect the duty of water is to bring out such reforms as will tend to materially increase the efficiency of the water used.

### RAINFALL.

The rainfall, although not subject to the control of the irrigator, may be taken advantage of to greatly aid his growing crops and materially lessen the quantity of

water used in irrigation. In the following table is shown the amount of rainfall for the past ten years, as deduced from the observations made at some fifty stations throughout the State:

*Monthly and annual rainfall for State of Utah.*

| Year. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Ins.* | *Ins.* | *Ins.* | *Ins.* | *Ins.* | *Ins.* | *Ins.* | *Ins.* | *Ins.* | *Ins.* | *Ins.* | *Ins.* | *Ins.* |
| 1892 | 0.85 | 0.77 | 1.52 | 1.06 | 1.55 | 0.46 | 0.28 | 0.27 | 0.09 | 1.08 | 0.30 | 1.27 | 9.30 |
| 1893 | .94 | 1.35 | 2.05 | 1.15 | .77 | .02 | .79 | 1.23 | .84 | .29 | .83 | 1.30 | 11.56 |
| 1894 | 1.18 | 1.11 | 1.05 | .86 | .44 | .84 | .71 | .81 | 1.36 | .47 | .05 | 1.94 | 11.43 |
| 1895 | 1.67 | 1.25 | 1.24 | .58 | 1.16 | .43 | .57 | .35 | .60 | .56 | 1.47 | .78 | 10.66 |
| 1896 | .81 | .46 | .99 | 1.07 | 1.52 | .20 | 1.81 | 1.04 | 1.00 | .61 | 1.23 | .46 | 11.20 |
| 1897 | 1.53 | 2.35 | 2.22 | .89 | .42 | .25 | .55 | .40 | 1.64 | 2.18 | .96 | 1.16 | 14.55 |
| 1898 | 1.07 | .47 | 1.24 | .72 | 3.02 | .78 | .35 | .60 | .10 | .67 | .96 | .63 | 10.61 |
| 1899 | 1.14 | 1.73 | 2.46 | .58 | .79 | .58 | .66 | .96 | .05 | 1.50 | .70 | .95 | 12.10 |
| 1900 | .43 | .57 | .19 | 2.46 | .36 | .16 | .09 | .34 | 1.26 | .87 | 1.51 | .14 | 8.40 |
| 1901 | .68 | 1.90 | .84 | .69 | 1.29 | .25 | .41 | 1.63 | .23 | 1.04 | .29 | .81 | 10.04 |
| Average .. | 1.03 | 1.19 | 1.44 | 1.01 | 1.13 | .40 | .62 | .76 | .71 | .93 | .83 | .94 | 10.99 |

The figures above indicate that the period of heaviest rainfall occurs in February, March, April, and May. It is possible for the irrigator to so plant and cultivate his crops as to utilize the greater portion of the rainfall during this period, and have them so far advanced by the end of the flood season as to require only a comparatively small amount of water to mature them.

### METHODS OF DISTRIBUTING WATER.

The distribution of water on the time basis is to be highly commended. By this system each irrigator, whether his farm consists of 1 or 40 acres, is furnished with as large a flow as he can use effectively and is thus enabled to flood his crops quickly, which, in addition to saving both time and labor, enables him to irrigate successfully a much larger area than he could by the use of a continuous flow proportionate in size to his rights in the canal.

### WASTEFUL USE.

There are many irrigators who are wasteful of water and allow it to flow off the field in large quantities. This waste decreases the area served by a canal or stream, and damages not only the irrigator who uses water to excess but those below.

### LOSS AND GAIN DUE TO SEEPAGE IN CONVEYING WATER.

Where the water to which a canal is entitled is measured at any considerable distance above the place of use, gains or losses in the flow of the canal will affect the quantity of water received by the land. During the season of 1900 measurements were made to determine the amount of water thus gained or lost by several of the canals. On most of the canals laterals were taken out at such short intervals as to make measurements impracticable. The amount of seepage from the Provo Bench and the Timpanogas canals was measured a number of times during the season. The section of the Provo Bench Canal on which the measurements were made lay between the measuring weir near the head and the point at which the canal gains the top of the bench. In this distance of 1½ miles the canal traverses the sidehill in a forma-

tion of coarse, gravelly cement, which when well silted forms an almost water-tight channel. From a number of measurements made during the season it was found that this section of the canal gained from seepage slightly more water than it lost, the average increase being 0.155 cubic feet per second. It is probable that this increase came from the lands irrigated by the Alta Ditch located above. The section of the Timpanogas Canal on which the seepage measurements were made extended from the measuring flume near the head of the canal to the point at which the canal gained the top of the bench. The line traverses the sidehill bounding the river bottoms, the soil of which is extremely porous, and the loss is large. At numerous places small, trickling streams issue from the canal bank and either evaporate or make their way to ditches below. The measurements made showed that in a mile and a half the canal lost slightly more than 25 per cent of the water taken in at the head. This loss, however, in no way affects the amount received by the irrigators, since the weir over which their part of the river's supply is measured is located on top of the bench and below the section in which the loss occurs.

## RETURN SEEPAGE ALONG PROVO RIVER.

With a view of determining the amount of water which returns to the river after having been diverted, a series of measurements was made during the month of August, 1900, the portion of the river measured lying between its entrance into Kamas Valley and its mouth in Utah Lake. In this distance, which approximates 50 miles, the river passes through three valleys—Kamas, Provo, and Utah Lake valleys—and through two canyons which separate these valleys. (See maps, p. 96.)

The river was divided into five sections, in each of which the return seepage was determined separately. In the study of each section it was necessary to determine four factors, viz, the flow of the river at its point of entrance to the section, the amount of all diversions, the inflow from all tributaries, and the flow of the river at the lower end of the section. From the data thus obtained the tables which follow have been derived.

The following table gives the gain in the river from seepage in passing through the Kamas Valley:

*Table showing return seepage in Kamas Valley.*

[Length of section, 9.5 miles.]

| | August 2–4. | | August 21–25. | |
|---|---|---|---|---|
| | Inflow. | Outflow. | Inflow. | Outflow. |
| | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* |
| Discharge, upper end Kamas Valley | 65.47 | | 61.51 | |
| Inflow to river from Moons Mill Race | 8.76 | | 8.35 | |
| Diversions from river in section: | | | | |
| Moons Mill Race | | 8.76 | | 8.35 |
| Sunrise Canal | | 3.43 | | 2.88 |
| South Kamas Canal | | 15.19 | | 14.29 |
| Washington Canal | | .00 | | .00 |
| Individual ditches | | 18.10 | | 15.23 |
| Discharge, lower end Kamas Valley | | 35.86 | | 33.31 |
| | 74.23 | 81.34 | 69.86 | 74.01 |
| Total outflow of section | | 7.11 | | 4.15 |
| Gain in section | | | | |

During the greater part of the irrigation season a large amount of seepage water makes its appearance along the foot of Kamas Bench, coming from the irrigated lands under the Washington and South Kamas canals. At the time the above measurements were made the seepage from this source had decreased noticeably from the amount that came to the surface during the early part of the season. When it is considered that this decrease was in all probability due to the cutting off of the supply of the Washington Canal in the first part of July, it would seem that the gain in the river's flow during the early part of the season had been much greater than that given above. This conclusion is further borne out by the variation in the two sets of measurements.

### CANYON SECTION BETWEEN KAMAS AND PROVO VALLEYS.

Throughout this section the river is confined in a narrow canyon, along which there are a few individual ditches. Several small tributaries also join the river. Their flow, however, was not measured; hence the figures given in the following table represent, in addition to the gain due to return seepage, the flow of these tributaries:

*Table showing return seepage between Kamas and Provo valleys.*

[Length of section, 7.25 miles.]

| | August 2–4. | | August 21–25. | |
|---|---|---|---|---|
| | Inflow. | Outflow. | Inflow. | Outflow. |
| | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* |
| Discharge, lower end Kamas Valley | 35.86 | | 33.31 | |
| Diversions from river in section: Individual ditches along canyon | | 6.25 | | 5.15 |
| Discharge, upper end Provo Valley | | 51.30 | | 48.37 |
| Total | 35.86 | 57.55 | 33.31 | 53.52 |
| Gain in section | | 21.69 | | 20.21 |

### PROVO VALLEY SECTION.

During the whole month of August, and for some time prior thereto, the entire discharge of the several creeks which enter this section of the river was diverted and used for irrigation, so that at the time the measurements were made none of the water from these creeks reached the river except through seepage. As both the Spring Creek Canal and the Charleston Canal derived their supply from Spring Creek and from the seepage water from the lands irrigated under the Wasatch Canal, McDonald Ditch, and North Field Ditch, they were treated as continuations of these systems, and not as canals deriving their supply from the river direct. In the table following the facts relative to return seepage in Provo Valley are strongly brought out.

*Table showing return seepage in Provo Valley.*

[Length of section, 11 miles.]

| | August 2–4. | | August 21–25. | |
|---|---|---|---|---|
| | Inflow. | Outflow. | Inflow. | Outflow. |
| | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* |
| Discharge, upper end Provo Valley | 51.30 | | 48.37 | |
| Diversions from river in section: | | | | |
| Wasatch Canal and McDonald Ditch | | 21.71 | | 14.35 |
| North Field Ditch | | 19.29 | | 16.87 |
| Midway Canal | | 8.86 | | 4.52 |
| Island Ditch | | 3.03 | | .00 |
| Discharge, lower end Provo Valley | | 99.07 | | 93.92 |
| Total | 51.30 | 146.96 | 48.37 | 129.66 |
| Gain in section | | 95.66 | | 81.29 |

The large gain in the river's flow in passing through the valley is not entirely due to seepage water, part of the water coming from springs which are not used for irrigation and flow directly into the river. The hot mineral springs which rise on the west side of the valley near Midway are examples of the latter. The water issues from these springs, or "hot-pots" as they are locally known, at a temperature approaching boiling point. A small amount of this water is used for irrigation, but the greater part sinks in the porous "pot-rock" formation and eventually finds its way to the river.

### CANYON SECTION BETWEEN PROVO VALLEY AND UTAH LAKE VALLEY.

Irrigation in this canyon is limited to one or two acres supplied from small springs. The most important tributaries entering the river are Deer Creek, North Fork, South Fork, Bridal Veil Falls, and Pole Canyon Creek, the combined flow of which is represented as gain in the following table:

*Table showing gain in flow of Provo River in canyon between Provo and Utah Lake valleys.*

[Length of section, 11 miles.]

| | August 2–4. | | August 21–25. | |
|---|---|---|---|---|
| | Inflow. | Outflow. | Inflow. | Outflow. |
| | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* |
| Discharge, lower end Provo Valley | 99.07 | | 93.92 | |
| Discharge entering Utah Lake Valley | | 184.09 | | 175.04 |
| Total | 99.07 | 184.09 | 93.92 | 175.04 |
| Gain in section | | 85.02 | | 81.12 |

### SECTION OF RIVER IN UTAH LAKE VALLEY.

The discharge of the river into this section was measured a short distance above the mouth of the canyon, about a quarter of a mile above the head of the Provo Bench Canal. The lower measurement was made about 1 mile west of Provo City. The river at this point was dry during the period of measurement so that no outflow

measurement appears in the table. There being no surface inflow from any source, the gain given in the following table represents the return seepage from the various canals.

It might be supposed that the gain in the river's flow in this section would be greater than that shown in the following table, but the location of the larger canals on both sides of the river is such that the water lost by the higher canals is caught by those lower down and is thus carried out of the river's basin, so to speak, and instead of finding its way back to the river channel as seepage, makes its way into the sloughs which surround the lake.

*Table showing return seepage to Provo River, in Utah Lake Valley.*

[Length of section, 8 miles.]

| | August 2-4. | | August 21-25. | |
|---|---|---|---|---|
| | Inflow. | Outflow. | Inflow. | Outflow. |
| | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* |
| Flow of river at upper gauging station | 184.09 | | 175.04 | |
| Diversions from river in section: | | | | |
| Provo Bench Canal | | 27.96 | | 30.14 |
| Roberts Ditch | | 2.14 | | 2.27 |
| Parks and Roberts Ditch | | 4.33 | | 3.53 |
| West Union Canal | | 26.09 | | 22.85 |
| Lake Bottom Canal | | 6.09 | | 7.89 |
| Timpanogas Canal | | 7.80 | | 10.38 |
| Upper East Union Canal | | 18.14 | | 15.77 |
| Provo City Water System | | 8 | | 8 |
| East Union Canal | | 22 | | 20.01 |
| City Race | | 15.30 | | 16.25 |
| Factory Race | | 28 | | 25.50 |
| Tanners Race | | 6.43 | | 8.24 |
| Little Dry Creek | | 7.04 | | 7.39 |
| River-bottom ditches | | 10.17 | | 8 |
| Flow of river at lower gauging station | | .00 | | .00 |
| Total | 184.09 | 190.49 | 175.04 | 186.22 |
| Gain in section | | 6.40 | | 11.18 |

## WATER RIGHTS ON PROVO RIVER.

At no time in the history of settlement on the Provo have the water rights on the upper reaches of the river been associated or to any extent involved in the controversies over water rights on the river in Utah Lake Valley, the rights on the two sections being considered separate and in no way related to one another. For this reason, and also for the sake of convenience, the stream will be taken up in two sections, the section of the river and its connected systems in the Utah Lake Valley forming one section, the upper portion of the river in Provo and Kamas valleys forming the other section. As the lower section of the river was the first on which settlement was made, this portion of the stream is given first consideration.

### THE LOWER SECTION OF THE RIVER.

The first use of Provo River for irrigation was made by a community of some thirty families who, early in the spring of 1849, located on Provo River about 2 miles

west of the present site of Provo City. In 1850, in addition to several small individual ditches, East Union Canal and Little Dry Creek Canal were taken out. These were subsequently enlarged to their present size. In 1853 the first steps were taken toward the establishment of rights to water. Applications were made from various parts of the Territory to the Territorial legislature for "grants" to water from the natural streams. One extravagant grant made by this body gave to ten settlers the exclusive right to the use of one-half of the entire flow of Provo River. The parties failed, however, to make use of the portion of the river granted them, and their rights were subsequently acquired by other settlers.

In 1856 or 1857 the Lake Bottom Canal was commenced, and in the same year water was conveyed through its upper portion. The small amount at first diverted was afterwards increased and the canal enlarged and extended. In the same year and during the one or two years following several other ditches were taken from the river, including the majority of the river-bottom ditches and the three mill races at present controlled by Provo City. These river-bottom ditches for the most part were constructed and owned by individuals.

In 1862 the Provo Bench Canal was begun, but, owing to difficulties in its construction, it was not finished until 1864. From this time until 1872 no new ditches were taken from the river. In 1872 Upper East Union Canal was begun, and Enterprise and Hooper canals a year or so later. In 1878 the Timpanogas Canal Company was organized, and in the same year its canal commenced. Water was first turned into this canal in 1879 or 1880, so that its rights to water are considered as having been acquired at this time. Since 1880, with the exception of the Blue Cliff Canal, no new diversions have been made, the Timpanogas right being the last primary right acquired.

During all these years from 1849 to 1880 the water supply furnished by the river had been adequate for the needs of all. From 1879 to 1881, however, the supply failed partially, and the amount of water furnished by the river barely satisfied the needs of the canal interests. The flow of the river entering the valley was further decreased by diversions in Provo Valley, which had increased from year to year until, in 1881, the entire low-water flow of the river was taken out for irrigation purposes. In the spring of 1882 a committee, consisting of John E. Booth and Roger Farrar, was delegated by the various canal interests on the lower section of the river to investigate the nature and extent of all the diversions made on the stream, both in Utah Lake Valley and on the upper reaches of the streams. The report of this committee showed that the entire low-water flow of the river was diverted for irrigation purposes in Utah Lake Valley, and that the diversions from the river on the upper reaches were rapidly increasing. This investigation was made as a step toward the establishment of rights to water from Provo River.

During the two years following this examination the demand for water from the lower section of the river rapidly increased, and at times the disagreements assumed serious form. In January, 1884, those entitled to water agreed upon a basis of division of the stream. This agreement was carefully framed and based upon the length of time each canal had used water and the amount of land that was dependent upon it for its water supply. All rights acquired prior to 1880 were conceded as primary and under the agreement were acknowledged of equal value.

The shares of the stream allotted to the several canal interests under this agreement were as follows:

*Discharge of water under 1884 agreement.*

| | Share. |
|---|---|
| Provo Municipal Corporation | 0.43 |
| Controlling East Union Canal | .10 |
| Factory Race | .15 |
| Tanners Race | .10 |
| City Race | .08 |
| Enterprise and Hooper canals, joint share | $\frac{1}{11}$ |
| Provo Bench Canal, including North Union Canal | $\frac{1}{4}$ |
| Lake Bottom Canal | $\frac{1}{11}$ |
| Upper East Union Canal | $\frac{1}{11}$ |
| Timpanogas Canal | $\frac{1}{11}$ |
| Little Dry Creek Canal | $\frac{1}{11}$ |
| River-bottom ditches | .0919 |

This basis of division, known subsequently as the 1884 agreement, was considered by all parties interested to be of a temporary nature, and was entered into only as a means to tide over the difficulties of seasons of short water supply, until a better and more permanent determination of rights could be made. From 1884 to 1893 this agreement was renewed yearly and little difficulty was experienced in satisfactorily apportioning the river on this basis.

In 1893 Provo City, because of a fancied encroachment upon its rights, brought suit in the district court against all the other canal interests, and in its complaint set forth its claim to forty-three one-hundredths of the river and its right to control and distribute the same to the inhabitants of Provo City. The city also claimed that during the irrigation season of 1892 and for some time prior thereto the defendant canal companies had wrongfully diverted a portion of the city's share of the river, and thus deprived the inhabitants of the city of their rightful amount of water during these periods. The case was in court until February 2, 1897, when the court appointed a referee, Mr. Charles De Moisey, to collect evidence and report his findings in the matter. On February 23, 1897, the referee proceeded to a hearing of the case, and on March 7, 1897, reported to the court that neither the quantity of water which had been diverted by the city nor the quantity necessary for the use of its inhabitants in the irrigation of lands and the operation of machinery could be determined from the evidence; that since 1884 the city had by agreement taken forty-three one-hundredths of the stream, and that its rights had not been interfered with.

After the above report was made no other steps were taken by either party to secure a final settlement of the rights involved, although the case was never dismissed. Later steps were taken by the municipal authorities to bring about a settlement by other and more satisfactory means. During the seasons of 1897 and 1898 a water commissioner was appointed by the several canal interests to measure, at various times during the season, the amounts of water actually received by each canal. With the results of these measurements in hand the parties interested had tangible data upon which could be based a settlement of the old disputes.

On July 6, 1898, a meeting of the representatives of all the canal interests was held in Provo, when a resolution was adopted providing for the appointment of a

commission which should adjust the rights of all parties and ask the court to issue a decree in accordance with its findings.

On September 10, 1898, pursuant to the above resolution, the representatives of the several canal companies met and elected a commission, consisting of P. M. Wentz, Roger Farrar, and Charles De Moisey. Immediately after their appointment the members of the committee organized and at once began the collection of evidence and testimony relative to the nature and extent of the diversions made by the several canals. From the data thus gained and from the measurements made by the water commissioner an agreement was drawn up, and on April 1, 1899, the report of the commission was presented to the representatives of the canal companies. The report as submitted was not satisfactory to all the companies and was amended in a few details. The recommendations, as amended, are given below:

(1) The high-water stage is found to be 22,000 cubic feet per minute, this volume of water being sufficient to fill all the canals and ditches.

(2) No division of water is necessary until the volume of water in Provo River has diminished to 18,000 cubic feet per minute, but at any stage of water exceeding 18,000 cubic feet per minute no canal shall be reduced to a less quantity of water than that apportioned to it on the basis of 18,000 cubic feet per minute.

(3) At a stage of 18,000 cubic feet per minute down to the next lower stage of apportionment the waters of Provo River shall be distributed as follows: Lake Bottom Canal, 50 thousandths; West Union Canal, 118 thousandths; Provo Bench Canal, 230 thousandths; Timpanogas Canal, 40 thousandths; Upper East Union Canal, 61 thousandths; Provo City, 353 thousandths; Little Dry Creek, 33 thousandths; river bottom, 90 thousandths; Fausetts Field, 17 thousandths; Carters and Tanners, 8 thousandths.

(4) At a stage of 15,000 cubic feet per minute down to the next lowest stage of apportionment the distribution shall be as follows: Lake Bottom Canal, 55 thousandths; West Union Canal, 119 thousandths; Provo Bench Canal, 177 thousandths; Timpanogas Canal, 36 thousandths; Upper East Union Canal, 67 thousandths; Provo City, 390 thousandths; Little Dry Creek, 40 thousandths; river bottom, 98 thousandths; Fausetts Field, 18 thousandths (Carters and Tanners 8 thousandths added to river bottoms).

(5) At a stage of 12,000 cubic feet per minute down to the lowest stage of water the distribution shall be as follows: Lake Bottom Canal, 60 thousandths; West Union Canal, 120 thousandths; Provo Bench Canal, 147½ thousandths; Timpanogas Canal, 30 thousandths; Upper East Union Canal, 72 thousandths; Provo City, 410 thousandths; river bottom, 97 thousandths; Little Dry Creek, 45 thousandths; Fausetts Field, 18½ thousandths (Carters and Tanners 7 thousandths added to river bottoms).

(6) The Dixon and Cluff fields, heretofore watered through the Alfred Young Ditch, are included in Provo City.

(7) The river bottoms are the lands lying on both sides of Provo River, to wit: On the east side of the river beginning with and including the lands of George Baum and James Stewart and extending up to and including the land of the Smith Brothers; on the west side of the river, the Roberts, Parks, and Nuttall fields and the lands under the Carter Ditch.

(8) The Browns, Snyder, Cook, and Vincent lands lying on the west side of the river will get their water from the old river channel on the west side of the river, which is supplied from springs rising in the river bottom; if the springs should cease at any time to furnish ample water, then the said lands shall have a proportionate share of the river water.

(9) The Lake Bottom shall be supplied from springs and the old river channel, above mentioned, but in the event the springs shall dry up and cease to furnish the needed water, then the said canal shall take its proportionate share of water from the river.

(10) The Fort Field shall take its supply of water from seepage in the river; but in the event the seepage water shall fail, then it shall be entitled to 300 cubic feet per minute at the 12,000 cubic-foot stage, the said water to be furnished proportionately by all the other canals.

(11) At all times the volume of water in the river shall be determined by adding together the quantities of water in the several canals. The volume of water in each canal shall be measured in the canal proper and as close to the place of use as practically possible, in weir dams of uniform construction; the Lake Bottom Canal shall be measured above what is known as Carys Point.

(12) (This section is not in original report.) In the event that any of the springs that now supply water for lands should dry up and cease to furnish the necessary water, then such lands now watered by springs shall receive their proportionate share of water direct from the river.

In order to secure the aforesaid distribution and to protect the future rights of the interested parties, we submit the following recommendation:

First. That some competent authority be established to see that weir dams are located, constructed, and maintained in suitable places; and in such approved manner that uniformity of measurement may be had.

Second. That an accurate system of measurement be established, continued, and recorded for the use and benefit of all water users.

Third. That an organization of all the users of water from Provo River in Utah Valley be perfected for the purpose of protecting the present supply of water, and of defending the rights of the present owners against all trespasses, and of increasing the quantity of water wherever practicable.

Fourth. That an organized, efficient system of distribution of water in the river bottoms be adopted in order that the water may be used to the best advantage and with economy.

When the amended report was submitted to the canal companies, Provo City, the West Union Canal Company, and the Little Dry Creek Irrigation Company each entered a protest against its acceptance, stating as their reason that under the proposed division the amount of water which they had hitherto been accustomed to receive would be materially reduced, and these companies gave notice that they would not submit to this proposed reduction.

The action of these three companies caused the rejection of the report, and again the Provo River canal companies were adrift so far as having their respective rights determined. Each of these investigations and reports, although rejected, had the effect of narrowing down the controversy over water and bringing about a more settled understanding among the parties interested as to their respective rights.

In 1900, rather than resort to the old 1884 agreement, all the canal companies, except the West Union Canal Company and two small unincorporated organizations, agreed to temporarily abide by the 1899 agreement, rejected the year previous. The objections of the West Union Company and the two small ditch companies were ignored and the water commissioner directed to apportion the river on the basis of this agreement, which instructions were followed throughout the irrigation season.

The dissenting parties at various times during the season, having previously given notice that they would not abide by the division being used, paid no attention to the amount of water the water commissioner allowed them, but took from the river amounts to which, in their opinion, they were entitled. This was considered a sufficient cause for action, and in the latter part of the season the various canal interests brought suit in the first district court against the West Union Canal, Smith Ditch, and Fausetts Field Ditch, and 23 individuals to quiet the title of the parties interested.

The case came up for hearing on January 3, 1902, and on January 29, the court having heard the proofs produced by the several parties to the action, rendered a decree in accordance with the evidence submitted, providing for the apportionment of the river's flow among the several canals and ditches on a basis very similar to that of the 1884 and 1899 agreements. According to the terms of the decree, no appor-

tionment or division of the river is necessary so long as the river's flow is "sufficient to fill the canals * * * to their full carrying capacity as they are now constructed." When the river's flow decreases to a volume not sufficient to fill all the canals, then a division of the flow is made, which apportionment remains the same until the river's flow decreases to 15,000 cubic feet per minute. Between this stage and the 12,000 cubic feet per minute stage a second apportionment is provided for, and between the 12,000 cubic feet per minute stage and the lowest stage of the river's flow the decree provides for a third apportionment. The proportion of the river's flow allowed each canal under each of these three apportionments is given in the following table:

*Apportionment of Provo River provided for by decree rendered January 29, 1902.*

| Name of company. | Down to 15,000 cubic feet per minute. | Down to 12,000 cubic feet per minute. | Below 12,000 cubic feet per minute. |
|---|---|---|---|
| Lake Bottom Canal Company | 0.0545 | 0.0595 | 0.0633 |
| Provo Bench Canal and Irrigation Company | .2295 | .1765 | .1444 |
| Timpanogas Canal Company | .0395 | .0355 | .0290 |
| Upper East Union Irrigation Company | .0605 | .0865 | .0708 |
| Provo City and S. S. Cluff and Sarah D. Dixon, jointly and undivided | .3525 | .3895 | .4023 |
| Little Dry Creek Irrigation Company | .0321 | .0390 | .0430 |
| Residents of the river bottoms, jointly and undivided | .0875 | .0875 | .0879 |
| West Union Canal Company and the Smith Ditch Company, jointly and undivided | .1175 | .1185 | .1265 |
| Fansetts Field Ditch Company | .0169 | .0180 | .0202 |
| Myron Tanner, taking water from what is commonly known as the Carter Ditch | .0010 | .0010 | .0011 |
| John Carter and all other persons, if any, taking water from said Carter Ditch | .0065 | .0065 | .0120 |

The decree further provides for the appointment by the court of a water commissioner, whose duties in the main shall be similar to those of the water commissioner heretofore appointed by the canal companies.

The flow of the river is to be determined by measuring the aggregate flow in all canals, the volume in each canal to be measured as near the point of first use as practicable. Provision is also made for the protection of the rights of those canal interests which are supplied with water, not from the river's flow direct, but from seepage which reaches the river channel after having been used for irrigation purposes on lands lying under the higher canals. The decree states explicitly that if at any time the amount of seepage water for any reason should fail to supply those canals which at present derive their supply from this source, those canals shall be entitled to their proportionate share of the river's flow according to the terms of the decree. These canals, however, so long as seepage water is available, shall draw their supply from this source, thus allowing the higher canals to increase the amount they divert.

This, the first decree that has ever been rendered on the Lower Provo, is really the outcome of an almost continuous controversy since 1884. The decree was, in fact, a consent decree, all parties to the action being in favor of all of its provisions. Of course the future alone can decide whether this decree will be wholly satisfactory, but judging from the fact that it was based on agreements which had for years been favored by a great majority of the interested parties, and also since the decree will be enforced and upheld by the court, it is probable that until contingencies arise which will necessitate the adjudication of all the rights on the entire

stream and all its tributaries the decree will confirm the titles of all the water users and settle the numerous disputes that have in the past arisen over the apportionment of the river's flow.

### THE UPPER SECTION OF THE RIVER.

The first appropriation from Provo River in Provo Valley was made by the North Field Ditch early in 1859. From that time until 1885 other canals were constructed, and in that year the first shortage was felt. Aside from the numerous petty disputes over water, which have been settled by officers of the Mormon Church, but few cases have come up in which any of the irrigation interests of Provo or Kamas valleys were involved. One of these involved the waters of Blue Ledge Creek, a small torrential tributary of the Provo. The plaintiffs, Isaac R. Baum, Samuel Lee, and Abram Hatch, who in 1883 appropriated to their use the entire flow of the creek, brought suit against James W. Thomas, who in 1891 ran a cut in the earth near the creek above plaintiffs' point of diversion and, claiming to have increased the flow of the creek, appropriated a portion of its flow. On June 17, 1898, the court decreed the plaintiffs the owners of the water of the creek, and further decreed that the defendant had no right whatever to any of the flow of the creek.

Another case, entitled Wasatch Irrigation Company et al. *v.* Edward Fulton et al., involved all the rights on the river in both Provo and Kamas valleys. The suit was the culmination of a controversy over water rights that had been going on since 1888 or 1889 between the water users on the river above Provo Valley and those supplied through the joint canal of the Wasatch Irrigation Company and the North Field Ditch Company. During the years between 1894 and 1897 the number of diversions made from the river above plaintiffs' dam increased rapidly and to such an extent as to materially decrease the amount of available water in Provo Valley. After numerous unsuccessful efforts to settle the case outside of the courts had been made, the Wasatch Irrigation Company, Charleston Irrigation Company, North Field Ditch Company, and about fifty individuals who were dependent upon them for their water supply brought suit against all other canal and private interests on the river above, including the canal organizations and some sixty individual appropriators of Kamas Valley. The Midway Irrigation Company refused to join the plaintiffs in the action, and was made a defendant. The case was begun in July, 1897, and in May, 1899, the court rendered a decree based primarily on the date of first use of water, the acreage irrigated, and the nature of land. All rights acquired prior to 1885 were classed as primary and all subsequent thereto according to date of first use, the amount to each appropriator being based on the acreage irrigated and the character of the land. The bench lands were allowed 1 cubic foot per second for each 60 acres, and the bottom lands 1 cubic foot per second for each 70 acres. This decreeing to each party a definite volume of water was a new feature, the precedent having been to give each appropriator a definite share of whatever water the stream furnished.

As the right of the Midway Irrigation Company to 5.5 cubic feet per second of the water of Provo River by virtue of its agreement with the Ontario Mining Company was conceded by all parties to the suit, and as the court held that the amount they received in addition by seepage through plaintiffs' dam did not properly come under the question at issue, the right of this company to the 5.5 cubic feet per second was admitted as valid, and by stipulation this amount was decreed to the company as long as there was that much in the river at its head gate.

The validity of the rights of the Sunrise Irrigation Company was also admitted by all parties concerned, and this company was decreed the right to 4 cubic feet per second, class 1 right.

The substance of the decree as rendered May 6, 1899, is here given. The decree distributes water, each class being entitled to water when the flow of the river exceeds the demands of preceding classes:

*Rights to water from Provo River in Provo and Kamas valleys.*

| Names. | Cubic feet per second. | Acreage on which decree was based. |
|---|---|---|
| Class 1: | | |
| The plaintiffs in common | 83 | 5,345 |
| John Benson | ½ | 35 |
| William Lark | ¾ | 40 |
| Mary A. Moon | ¾ | 40 |
| Fred Peterson | ⅛ | 8 |
| J. L. Larson | ¾ | 30 |
| G. O. Ellis | 1¾ | 100 |
| E. B. Leffler | ¾ | 20 |
| Henry Fraughton | ¼ | 10 |
| T. A. White | ⅝ | 17 |
| John O'Driscoll | ¾ | 20 |
| Samuel Gines | 1⅝ | 125 |
| Milton O. Turnbow | ⅛ | 15 |
| H. Bisel | ⅛ | 2 |
| Riley Fitzgerald | ¾ | 20 |
| Jack Bates | ⅛ | 15 |
| W. H. Walker, jr | ⅛ | 25 |
| Ed Dillon | ½ | 35 |
| Isaac R. Baum | 1⅛ | 115 |
| Abram Hatch, Joseph Hatch, and A. C. Hatch in common | ⅛ | 5 |
| John Buttery | ½ | 14 |
| Mary Davis | ¾ | 50 |
| George B. Jordan, John J. Jordan, and Allen Jordan in common | ¾ | 30 |
| Defendants South Kamas Irrigation Company | 16¾ | 1,050 |
| Thomas P. Potts | ½ | 35 |
| Thomas White | ⅛ | 4 |
| John Phillips | ¾ | 30 |
| F. P. Bowers | ⅛ | 8 |
| James A. Knight | 3¾ | 100 |
| John M. Reed | ¾ | 50 |
| Marshall Leffler | ⅛ | 1.25 |
| Ephraim Lambert | ⅛ | 1.25 |
| H. Moon | ⅛ | 30 |
| Daniel Simpers | ¾ | 60 |
| Robert Mitchie | ¼ | 13 |
| Daniel Mitchell | ⅛ | 25 |
| Jos. Ketchum | 1¾ | 90 |
| Ether Webb | ¾ | 20 |
| Class 1—Continued. | | |
| W. H. Walker | ¾ | 30 |
| Henry W. Walker | ⅛ | 5 |
| John Swift | ¾ | 20 |
| Joseph Morris | 1¾ | 130 |
| Abram Hatch | ¾ | 50 |
| J. D. Jones and R. L. Jones | 1 | 70 |
| Samuel Lee | ¼ | 10 |
| B. A. Norris | ⅛ | 15 |
| Class 2: | | |
| South Kamas Irrigation Company | 11¼ | 700 |
| Eliza Kinzie | ⅛ | 15 |
| John Jones | ⅛ | 25 |
| Henry E. Parry | 1¾ | 100 |
| Class 3: | | |
| Jack Bates | ⅛ | 15 |
| John Peterson | ¼ | 45 |
| Emil Sackerson | ¼ | 50 |
| Class 4: | | |
| John Buttery | ⅛ | 16 |
| Class 5: | | |
| Washington Irrigation Company | 21⅛ | 1,282 |
| Jack Bates | ⅛ | 25 |
| Carl H. Wilcken | ⅛ | 6 |
| William Paul | ⅛ | 12 |
| A. S. Potts, William Potts, George Potts, and T. P. Potts for A. S. Potts entry | ¼ | 45 |
| Class 6: | | |
| Samuel Lee | ¾ | 20 |
| John O'Driscoll | ⅛ | 15 |
| Carl H. Wilcken | ⅜ | 37 |
| Class 7: | | |
| William Paul | ⅛ | 18 |
| John O'Driscoll | ⅛ | 5 |
| Class 8: | | |
| Carl H. Wilcken | ⅛ | 6 |
| Class 9: | | |
| Ernest White | ⅛ | 25 |
| Ether Webb | ⅛ | 5 |
| Class 10: | | |
| John Buttery | ⅜ | 11 |

11. When same party is entitled to water in different classes, the quantity to which he is entitled is the aggregate quantity to which he is entitled in all classes.

12. When river's flow is insufficient to supply quantity of water awarded to any class, persons and parties of such class shall have flow distributed pro rata among them.

13. No class shall have use of water until flow of river exceeds demands of classes enjoying prior rights.

14. Fifteen individuals (named), having failed to establish their respective rights, are not entitled to divert water.

The decree further provided for a commission of three to distribute the water; one member to be appointed by the plaintiffs, one by the defendants, and the State engineer to act as the third member; and provided rules of action for the commission.

The provisions of the decree were satisfactory to all the plaintiffs and a majority of the defendants. The Washington Irrigation Company, the South Kamas Irrigation Company, and some twenty individual appropriators in Kamas Valley, appealed the case to the supreme court of the State, which affirmed the judgment of the lower court.

## CONCLUSIONS.

The results of these studies on the Provo seem to warrant the following conclusions:

(1) That owing to the varying nature of the water rights of the several canal interests deriving their supply of water from Provo River below the mouth of the canyon, and also since the Utah law provides that there shall be no priority among primary rights, the system of prorating the flow of the stream is very satisfactory, and is one to be commended. Steps, however, should be taken toward attaining greater accuracy in the measurement of the flow in the several canals, either by measuring weirs constructed on scientific principles or, better still, measuring flumes which have been carefully rated.

(2) That the method of distributing water from main canals on the time basis in localities where farms are comparatively small is conducive to a high duty of water.

(3) That there is an unnecessary waste of water, both in its distribution and in its subsequent use on the irrigated land, but that this waste is caused rather by the ignorance of efficient methods of distribution and use of water than by willful negligence on the part of the irrigator, and that by experience and study of existing conditions the irrigator will see the defect and take steps toward remedying it.

(4) That under the majority of Provo River canals entirely too much water is used. And along this same line it may be said that all measurements made during the season of 1900 go to show that in proportion to the amount of land irrigated the amount of water allotted to the river-bottom ditches is out of all proportion to the amount allowed the larger canals on either side of the river.

(5) That during the season of 1900, although complaint was made of shortage of water supply, the amount of water discharged by the Provo during the irrigation season, had it been apportioned properly, would have been adequate for the needs of all.

(6) That during the latter part of the irrigation season the supply of water in the lower reaches of Provo River is materially increased by return seepage from irrigated lands lying on the upper reaches of the stream, on which a generous amount of water is used during the early part of the season; and that in the absence of storage reservoirs, in which to store the surplus water of the river during the spring months, this use of water in the upper valleys should be encouraged.

(7) That the use of irrigation streams for the development of power, when such use in no way interfered with the use of the water for irrigation, is beneficial and should be fostered, as a direct means of bringing about the development of the State.

(8) Where the use of water for power purposes is detrimental to the development and growth of an irrigated section, the use of water for irrigation should take precedence.

## AMERICAN FORK RIVER.

American Fork River is the third largest stream flowing into Utah Lake. Its drainage area is between 60 and 70 square miles, but the run-off per square mile is larger than that of either Provo or Spanish Fork rivers. The flow is also more uniform because much of it comes from perennial springs, and because the stream rises in a number of small lakes on the summit of the Wasatch Mountains. The source is 18 or 20 miles northeast of where it empties into the lake. For a distance of 12 or 14 miles the stream traverses a rough mountainous country, and there is no irrigable land along it until it reaches the valley of Utah Lake. Here it waters 17,000 acres of land, on which are located the farming towns of Lehi, American Fork, and Pleasant Grove. The higher lands are cultivated, but near the shores of Utah Lake it is nearly all meadow and pasture land which is watered by the seepage from the irrigated lands above.

The river is diverted by three canals. Two, the American Fork and Pleasant Grove, are operated and controlled by the municipal corporations of American Fork and Pleasant Grove, respectively, while the other is controlled by the Lehi Irrigation Company, of which a majority of the stockholders own land in the vicinity of the town of Lehi. These canals all head near the mouth of American Fork Canyon, where a diversion weir has been built. From this weir the Pleasant Grove Canal runs southeastward for a distance of 4 or 5 miles to the irrigated land in the vicinity of Pleasant Grove. The Lehi Canal flows westerly until it gains the top of the Lehi Bench, then it divides into two branches which supply the bench lands, the town of Lehi, and the country around it. The American Fork Canal follows the river bottom for a long distance, then divides into several small branches to reach the lands surrounding the town of American Fork.

### WATER RIGHTS.

The water of this river has been used in irrigation for more than fifty years, as the first canals were built in 1851 or 1852. At first the ditches were small and poorly built, little or no regard being paid to slope, alignment, or cross section, the flow of each amounting to only what one or two men could use at a time.[a] Each settler in the community used this stream in turn until he was through irrigating, then the stream was taken by his neighbor, and so on until each irrigator in the settlement had been supplied. No restrictions were placed upon the user either as to the period of use or the amount of water applied to his land.

As the demand for water increased, these small ditches were sometimes united in order to better control the volume diverted. This continued until the several interests in the stream were represented by three organizations bound together by

[a] For several years after the settlers first came into Utah Lake Valley no public records were kept. Many of the settlers, however, kept private records or diaries and from these, through the courtesy of their owners, the data necessary to a description of the development of this section were obtained.

merely verbal agreements and each owning a roughly constructed canal system. In time, to secure better control of the stream, the heads of these canals were moved up the river to the mouth of the canyon near the present location of the joint diversion weir. Here the stream was divided proportionately among the several interests according to their rights, no regard being paid to the actual amount each canal received so long as each one received its share.

### APPORTIONMENT OF WATER.

At first the settlers had no means of making an accurate division of the stream, and it was not easy to satisfy all the parties concerned. So long as there was plenty of water in the stream, little difficulty was experienced in dividing it, but, as the season advanced and the water supply diminished, trouble commenced and continued to increase until the end of the irrigation season. The original plan of division was for a committee, composed of representatives of the three canals, in company with the water masters of these canals, to place logs, stones, and brush in the bed of the stream in such a manner as to turn through the roughly constructed head gates what, in the judgment of the committee, was the right proportion of the stream. This was satisfactory only so long as each settler received all the water he wanted. When some were forced to do with less, they would surreptitiously change the rock and brush dams so as to increase their share. This caused an undue shortage in the other canals and made it necessary for the committee to reapportion the stream. Sometimes this division had to be made every two or three days, and during exceptionally dry seasons the dams had to be changed daily. When interference became too frequent, complaints were made to the bishops of the several wards, and these would caution and in a friendly way reprimand the offenders, which usually put an end to such disturbances. When greater disputes arose, recourse was had to the higher ecclesiastical court, known as the High Council of the Stake, a decision of which was accepted as final.

From the time the first settlers came into the valley the water diverted was considered the property of the community which built the ditches. No individual rights were recognized as such, each settler's interest being considered as forming only an integral part of the community's right. Distribution between these rights was based on the theory that "the first in time was first in right." The first step toward the legal settlement of these water rights was in 1853, when the second Territorial legislature granted to Lehi one-third of the stream from July 1 to September 20, one-sixth from September 20 to December 1, one-tenth from December 1 to April 1 of the following year, and from April 1 to July 1, during the high-water season, such an amount of water as the canal could carry, not to exceed one-sixth of the flow of the stream during this period. This grant has stood undisputed ever since, and has formed the basis upon which the stream has been divided in subsequent adjudications. In 1874 the American Fork and Pleasant Grove canals were, by vote of their owners, placed under the municipal control of the towns of American Fork and Pleasant Grove, respectively. About the same time steps were taken to have Lehi Canal placed under the control of Lehi. This plan, however, failed, and the Lehi Company, until the date of its incorporation in 1880, controlled the portion of the stream granted it as an unincorporated organization.

From 1874 to 1879 there was continued trouble between the towns of American Fork and Pleasant Grove over the division of their portions of the river. Lehi Company's share during this time was never brought in question. During this period it was the custom for committees from each settlement or ward to meet each season and agree on a basis for the division of the stream. The following extracts from the minutes of the city council of American Fork show the unsettled condition of affairs during this period:

July 29, 1875. Citizens' mass meeting held to see to their rights to an equal division of American Fork between American Fork and Pleasant Grove wards.

August 9, 1875. Delegation from council of American Fork met with delegation from Pleasant Grove and settled the question as to the division of water for the present season.

July 28, 1877. Mr. Nichols, land commissioner, was instructed by council to have interview with commissioner of Pleasant Grove City in order to ascertain the quantity of water they shall receive in a neighborly capacity for the present season.

May 17, 1879. The water master instructed and authorized, until the water resources of both settlements are further investigated, to turn into the Upper Ditch (Pleasant Grove Canal) not to exceed one-fifth of the waters of American Fork Creek after passing Lehi Ditch—provided bench lands on American Fork side receive water in proportion to the amount given to bench lands on Pleasant Grove side.

In 1878 and 1879 the disagreement between American Fork and Pleasant Grove assumed a more serious form. These two districts were nearly of the same size, but Pleasant Grove received, in addition to its share of American Fork, the entire flow of two small streams. Ignoring this, it made a demand for one-third of the water of American Fork, or one-half of the stream remaining after Lehi's share was diverted. American Fork would only consent to Pleasant Grove taking one-fifth of the stream. Neither side would yield, and finally the case was taken before the High Council of the Stake. After taking testimony, the council decided that after deducting the share of the Lehi Canal, the American Fork Ward should receive five-sevenths of the stream and the Pleasant Grove Ward two-sevenths, the water to be divided by the water masters of the American Fork and Pleasant Grove wards; and in case these two water masters could not agree, they were to call upon the bishop of Alpine, who, with the bishops of their respective wards, were authorized to make a final decision. The high council also decided that the irrigation season should commence on the 15th day of April and expire on the 20th day of September. The council also recommended that a good and substantial dam, with iron gates, be constructed in order to make a just distribution of the water. The expenses of the commission which rendered this decision were $72.50, of which the American Fork Ward paid $42.50 and the Pleasant Grove Ward $30.

This decision was accepted by all parties and has since been the basis on which water has been divided among the three canals. In 1881 the right of Lehi to one-third of the stream was confirmed by the selectmen of Utah County sitting as a board of water commissioners.

The following is the text of the certificate issued by the water commissoners of Utah County establishing the right of the Lehi Irrigation Company to the water of the stream:

TERRITORY OF UTAH, *Utah County, ss:*

We, T. J. McCullough, Myron Tanner, and Johnathan S. Page, water commissioners of Utah County, do hereby certify that Lehi Irrigation Company is the owner of a primary right to the use

of water from American Fork Creek in Utah County as follows, to-wit: One-third of the whole of the waters of said creek for irrigation purposes from the first day of July to the twentieth day of September, and one-sixth of said waters from the twentieth day of September to the first day of December, and one-tenth of said waters from the first day of December to the first day of April, and from the first day of April to the first day of July of each and every year a portion of the waters of said creek equal to one-half the quantity that the Lehi Ditch will carry at its present capacity, the said capacity being nine feet three inches wide and twelve and one-quarter inches deep, with average fall of the ditch, or not to exceed one-sixth of said American Fork Creek, between the said first day of April and the first day of July.

In witness whereof we have hereunto set our hands this 30th day of April, A. D. 1881.

T. J. McCULLOUGH,
MYRON TANNER,
JOHNATHAN S. PAGE,
*Water Commissioners, Utah County.*

In 1886 the recommendation of the High Council of the Utah Stake of Zion that a substantial weir be constructed was carried out, the three corporations joining in its construction. The weir is built of timber cribs filled with rocks, so constructed as to provide three openings through which the supplies for the three canals are drawn. The aggregate length of the three weirs is 42 feet. During the winter months this is decreased to 33 feet.

Since then no little trouble has been experienced in dividing the stream. On December 5, 1899, the three corporations entered into an agreement for the division of the stream during the winter months. The total length of the weir is 33 feet. This agreement provides that the Lehi Irrigation Company shall have the water flowing over 5½ feet of the weir, the Pleasant Grove over 2½ feet of the weir, and the American Fork the water flowing over the remaining 25 feet of the weir. As a part of this arrangement the American Fork Ditch is to furnish another ditch with water for culinary purposes. The following table gives each canal's portion of the water of the American Fork River during the different periods of the year.

*Division of water of American Fork River.*

| Canal. | Aggregate width of weir, 42 feet. | | | | Aggregate width of weir, 33 feet. |
|---|---|---|---|---|---|
| | Apr. 15 to July 1. | | July 1 to Sept. 20. | | Sept. 20 to Apr. 15, width on weir. |
| | Proportion of stream. | Width on weir. | Proportion of stream. | Width on weir. | |
| | | *Feet.* | | *Feet.* | *Feet.* |
| Lehi | ⅙ | 7 | ⅓ | 14 | 5½ |
| Pleasant Grove | ⅐ of ⅙ | 10 | ⅐ of ⅓ | 8 | 2½ |
| American Fork | 6/7 of ⅙ | 25 | 6/7 of ⅓ | 20 | 25 |

## CANAL ORGANIZATION AND MANAGEMENT.

### AMERICAN FORK CANAL.

As has been explained before, the American Fork Canal is owned by a municipal corporation, and all questions regarding water are referred to the council committee on irrigation and water courses. Distribution is made from the main canal by a head water master and from the laterals or sects to the irrigated land by subwater

masters. An annual tax is levied to pay the salaries of these officials. It amounts to 20 cents an acre in cash and 20 cents an acre in labor for each acre irrigated. Water is given only where absolutely needed, and during seasons of scarcity the priorities of rights of various irrigators are carefully observed. As there were no public records kept prior to 1880, all rights acquired before that date are considered as primary. Rights acquired subsequent to 1880 are classed according to the date of first use. Differing from rights under either of the other canal systems, the individual rights under the American Fork Canal inhere in the land on which the water was first used, and under no circumstances can water be bought, sold, or transferred without the land.

The canal irrigates approximately 6,000 acres. Of this about one-half is along the shores of the lake and is so wet as to require little water. The principal crops are hay, grain, alfalfa, sugar beets, and fruit. The twenty-five thirty-thirds of the stream which is received during the winter is used for power purposes.

### PLEASANT GROVE CANAL.

The irrigation system of the Pleasant Grove district is managed like the American Fork Canal, as a municipal property. The water masters are under the direction of the city council of Pleasant Grove. Water is distributed to users so that each one receives water a length of time in proportion to the amount of land he is entitled to irrigate. At the beginning of the irrigation season the water masters prepare schedules for their respective sections and arrange the periods of rotation of the stream among the various irrigators, so that those who have the water of the stream during the night on one turn may on the next turn have it in the daytime. This is accomplished by providing that the time between turns shall be an odd number of half days. Ten and one-half days is a common period. At each turn the water masters under the several ditches send a notice to each irrigator informing him as to when his period of use of the stream begins and ends. The following is a blank copy of a water master's notice in the Pleasant Grove district:

No. ——. PLEASANT GROVE, ——, 190 .

Mr. —— ——:

You are hereby notified that it is your turn to use the water on —— from the —— Ditch, commencing on ——, 190—, at —— o'clock —m.

—— ——, *Water Master.*

Per —— ——, *Deputy.*

Instead of diminishing the size of the stream used by irrigators as the water supply decreases, the period of use is diminished, the size of the stream remaining constant. The shortest period for the use of the stream allowed during the past three or four years has been one-half hour per acre for each turn or "watering," as it is locally known.

The area entitled to water in the Pleasant Grove district approximates 5,000 acres. Of this, nearly one-half lies along the shores of the lake and requires no irrigation. The lands which are irrigated are entitled to ten forty-seconds of the river from April 15 to July 1, eight forty-seconds from July 1 to September 20, and twenty-five thirty-thirds from September 20 to April 15 of the following year. In

addition, this district controls the entire flow of Grove and Battle creeks, two small streams which rise in the mountains 3 miles east of town. One peculiar characteristic of these streams is that they reach their highest discharge in July and August, and this increase tends to offset the reduced supply from the river, causing the water supply of the district to remain practically constant throughout the season.

The right to the water controlled by Pleasant Grove is recorded in the name of Pleasant Grove City, as a municipal corporation. The individual irrigators of the district have nothing whatever to show for their right to the water they use, except as their names are given on the list of irrigators kept by the water master, which list gives the names of the irrigator, date of first use of water, acreage entitled to water, and location of irrigated land. All land watered prior to 1878 is considered as having a primary right. These rights are valued at from $15 to $25 per share, a share representing sufficient water to irrigate 1 acre. All land brought under irrigation between 1878 and 1890 has what is termed a "surplus right," which entitles the land to water when the supply available is in excess of the demands of the primary rights. Lands served under such rights are usually devoted to wild hay or some similar crop, which requires only one good watering. These rights sell for from $3 to $8 per share. Land brought under cultivation since 1890 has no right to water. In both the Pleasant Grove and Lehi districts all classes of water rights are transferable, yet few if any transfers are made wherein land and water are sold separately, owing to the fact that the demand for water exceeds the supply.

### LEHI IRRIGATION SYSTEM.

The Lehi district is not wholly dependent upon American Fork River for its water supply. During a part of the irrigation season a portion of its water supply comes from Dry Creek. The Lehi Company receives eleven twenty-sixths of this stream from April 1 to July 1 and from July 1 to July 10 it receives six and five-tenths twenty-sixths. On July 10 its supply from this source is cut off and during the remainder of the season the district is supplied from American Fork River.

The water from the two sources above mentioned is distributed by two main lines and some eight or ten principal laterals or sects, variously named according to the locality supplied.

The capital stock of the company has been increased from time to time until it is now $64,559, divided into three classes of shares, viz, primary shares, 3,856 in number, par value, $10; secondary shares, 3,093 in number, par value, $8; and grass shares, 251 in number, par value, $5. This last class of stock is similar to the "surplus rights" of the Pleasant Grove district and entitles the holder to water only during the spring flood season. The management of the system is vested in a board of directors, elected biennially. The several members of the board and the secretary of the company receive no regular salary, but are paid for the time devoted to the transaction of canal business. The water master and his deputies receive fixed salaries during the irrigation season as their duties occupy their entire time. For the maintenance of the system and the pay of the officers, an annual tax, payable either in labor or cash, is levied, based upon the number of acres of land irrigated. The method of distributing the water supply from the main canals and principal sects to

the irrigated land is similar to the methods practiced in the Pleasant Grove and American Fork districts.

### OTHER CANALS TAKING WATER FROM DRY CREEK.

In addition to the Lehi Irrigation Company there are two other corporations interested in the waters of Dry Creek. These are the municipal corporation of Alpine and the North Bench Canal Company. Of these three, the Lehi Company, or rather, its predecessors in interest, was the first appropriator. As early as 1850 settlers near the present site of Lehi appropriated all the waters of the creek that reached their land. This was only a portion of the creek's flow, a large percentage being lost by seepage. In 1851 or 1852 settlers near Alpine appropriated such seepage, and by cleaning and improving the creek channel between Alpine and Lehi prevented the excessive loss in this section and secured the use of the water saved.

In 1880 the settlers using the waters of Dry Creek in Alpine district, by popular vote, placed the control of the water supply in the hands of the municipal authorities of Alpine, since which time the irrigation system has been controlled and managed in the same way as are those of the American Fork and Pleasant Grove districts.

At the time control was vested in the city the value of the individual rights of the district, termed the capital stock of the company, was placed at $14,000, divided into 1,400 shares. In 1897 this stock was increased to $16,150, divided into 1,615 shares. These shares are now worth $25 for a primary right and $15 for a secondary right, with few shares to be had at these figures. Each share represents water for the irrigation of 1 acre.

The Alpine irrigation system consists of three small main canals and their distributing sects.[a] Its total length is about 3 miles. The water master and his deputies are under the direction of the mayor and city council, who are made ex officio the officers of the irrigation corporation. Expenses are met by an annual tax levied upon the shareholders. The area irrigated in average years approximates 1,800 or 2,000 acres. The greater part is devoted to such crops as require only one or two waterings, and those during the early part of the season when water is abundant.

The third company interested in the waters of Dry Creek was incorporated in 1878 as the North Bench Canal Company, with a capital stock of $12,600, divided into $10 shares, each share representing water for the irrigation of 1 acre. Water was first taken out in 1877, at which time the irrigators filed on two-thirteenths of the stream during April, May, and June, and on one-fourth of the stream from October 1 to April 1, which portions of the stream had hitherto remained unappropriated. Their right to this water was considered as a secondary right, Lehi and Alpine having previously appropriated the entire low-water flow of the creek and its tributaries.

The canal was enlarged in 1878 to a width of 6 feet and a depth of 1½ feet, the line being carried on a grade of 9 feet per mile. The head of the canal is located about one-half mile southwest of Alpine, at which point a rough timber dam diverts

[a] The term "sect," which is used synonymously with the terms ditch and lateral, is of local origin, and in all probability is a corruption of the Spanish-American term "acequia," an irrigation canal.

the water from the creek into the canal. From its head the canal takes a westerly direction for about 6 miles, and during the period to which it is entitled to water distributes its supply to the bench lands lying northwest of Lehi. The management of the canal is vested in a board of five directors, one of whom is president of the corporation. The water master is appointed annually by the board and is under its direction. The expense of maintenance is met by a tax, varying from a very small amount to the maximum limit of 10 per cent on the par value of the stock. The average rate for a number of years has been between 4 and 5 per cent, which is equivalent to a tax of 40 or 50 cents per acre. As a rule this tax is paid in labor on the canal. The area irrigated approximates 1,200 acres. The principal crops grown are alfalfa and grain.

### ESTABLISHMENT OF WATER RIGHTS TO DRY CREEK.

From the first settlement on Dry Creek, in 1850, up to 1889, no steps were taken to define the rights of either of the three corporations to the water they controlled. Numerous petty disputes had from time to time arisen, but in the majority of cases the settlement effected did not define the rights of either of the parties concerned.

During the season of 1889 the water supply was barely sufficient to satisfy the primary rights. On December 5, 1889, Alpine town corporation and Lehi Irrigation Company entered into an agreement in regard to their respective rights to Dry Creek. By this agreement each of the two corporations was to have one-half of the water of the creek during April, May, June, and the first ten days of July. After July 10 and until the 1st of April of the year following Alpine was to have the entire stream and the Lehi Company was to draw its entire supply from American Fork River. It will be noticed that in this agreement the rights of the North Bench Irrigation Company to a portion of the flood flow of the creek were entirely ignored. This company on March 15, 1892, by agreement with the Lehi Company, was given two-thirteenths of Lehi's half of Dry Creek during April, May, and June, and during the first ten days of July was allowed one-half of Lehi's one-half. After having thus compromised with Lehi, the North Bench Company took steps to regain its right to the portion of the stream claimed by Alpine. As Alpine was not willing to submit the case to arbitration, as the Lehi Company had done, the North Bench Company took the case into the first district court of the Territory, and on July 14 a decision was rendered in its favor, granting it the portion of the stream claimed. Following is the substance of the decree:

That the North Bench Company is entitled to the exclusive use of two-thirteenths of all the waters of Dry Creek and its tributaries (except Grove Creek, which belongs to the Alpine Company), to be measured at the Lehi and Alpine Dam, above Alpine, during all of April, May, and June of each and every year.

That the North Bench Company is entitled to one-fourth of all the waters of Dry Creek (except Grove Creek), to be measured at the same point, during all of October, November, December, January, February, and March.

That the Alpine Company, etc., are enjoined from entering upon or interfering with any of the waters hereby awarded to the North Bench Company.

That, in addition to the one-thirteenth of Dry Creek and its tributaries (except Grove Creek) which the Alpine Company permits to flow down to the Lehi Company, the said Alpine Company is required to permit another one-thirteenth of said waters to flow down, amounting in all to two-thirteenths of the whole stream, for the use and benefit of the North Bench Company, for the irrigation and cultivation of its lands, during all of April, May, and June of each year; and likewise, the said

Alpine Company is required to permit one-fourth of all the waters of Dry Creek (except Grove Creek) to flow down for the use of the North Bench Company during all of October, November, December, January, February, and March.

By this decision the North Bench Company received two-thirteenths of Alpine's half of Dry Creek during April, May, and June, and was awarded one-fourth of all the flow of Dry Creek during the remainder of the year. The flow from Grove Springs belonged to the Alpine Company, whose right to the same was not questioned.

The following table gives the portion of Dry Creek to which each of the three above-mentioned corporations is entitled:

*Schedule of pro rata distribution of Dry Creek.*

| Corporation. | April 1 to July 1. | July 1 to July 10. | July 10 to October 1. | October 1 to April 1. |
|---|---|---|---|---|
| Lehi Irrigation Company | 11/13 | 1/2 | ..... | ..... |
| Alpine | 1/13 | 1/2 | Entire flow | 1/2 |
| North Bench Canal Company | 1/4 | 1/2 | ..... | 1/2 |

Since the rights of the three corporations were settled in 1892 and 1893 little difficulty has been experienced in dividing the stream.

## USE OF WATER.

The writer spent the summer of 1900 in this district, measuring the flow of the streams before described, gauging ditches and keeping a record of the water used, through the cooperation of the various water masters. By keeping constantly at work, the whole district could be covered and a complete set of measurements made once every two weeks.

American Fork River was highest in May. On the 25th, 26th, and 27th of this month the discharge was 250 cubic feet per second. The lowest flow measured was September 16 to 20, when it was 25.9 cubic feet per second. The record began May 21 and ended September 21.

The total discharge for the last eleven days in May was 4,404.44 acre-feet; for June, 7,306 acre-feet; for July 3,277 acre-feet; for August, 1,774 acre-feet, and for twenty-one days in September, 1,084 acre-feet.

This water was not divided between the different canals in strict accordance with their rights, as will be seen by the following table, which gives what each canal received and what its share was under the schedule:

*Divison of American Fork River, 1900.*

| Date. | Total in river. | American Fork Canal. | | Lehi Canal. | | Pleasant Grove Canal. | |
|---|---|---|---|---|---|---|---|
| | | Discharge. | Scheduled share. | Discharge. | Scheduled share. | Discharge. | Scheduled share. |
| | Cu. ft. per sec. | Cu. ft. per sec. | Cu. ft. per sec. | Cu. ft. per sec. | Cu. ft. per sec. | Cu. ft. per sec. | Cu. ft. per sec. |
| May 29 | 241.64 | 190.63 | 143.829 | 42.98 | 40.273 | 65.07 | 57.538 |
| June 29 | 85.52 | 48.80 | 50.905 | 18.18 | 14.253 | 15.80 | 20.302 |
| July 13 | 46.18 | 21.19 | 21.991 | 15.63 | 15.399 | 9.35 | 8.796 |
| July 28 | 38.17 | 17.31 | 18.177 | 12.71 | 13.723 | 7.90 | 7.270 |
| August 10 | 22.51 | 14.25 | 15.481 | 11.34 | 10.857 | 6.92 | 6.192 |
| August 27 | 20.36 | 14.23 | 14.443 | 9.97 | 10.110 | 6.18 | 5.777 |
| September 14 | 23.65 | 12.75 | 13.278 | 9.67 | 9.617 | 6.19 | 5.495 |

The amounts received by the Lehi and Pleasant Grove canals were slightly in excess of their schedule rights, while the American Fork Canal received less than its scheduled amount. Both Lehi and Pleasant Grove canals lie above the American Fork Canal, and it is probable that the latter is helped by seepage.

The following table gives the discharge of Grove and Battle creeks in 1900, which was used by Pleasant Grove:

*Discharge of Grove and Battle creeks.*

| Date. | Grove Creek. | Battle Creek. |
|---|---|---|
| | *Cu. ft. per sec.* | *Cu. ft. per sec.* |
| May 29 | 1.596 | 2.571 |
| June 29 | 1.306 | 3.333 |
| July 15 | .835 | 4.925 |
| July 29 | 1.040 | 5.866 |
| August 27 | 1.085 | 6.962 |
| Average for season | 1.172 | 4.731 |

The following table gives the discharge of Dry Creek, its tributaries, and its several connected canal systems. The flow of Dry Creek includes that of Fort Canyon Creek, Schoolhouse Creek, and Grove Springs:

*Discharge of Dry Creek and the water diverted by the different canals in 1900.*

| Date. | Dry Creek. | North Field and city section. | High Bench section. | North Bench Canal. | Lehi's proportion. | Fort Canyon Creek. |
|---|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* |
| May 23 | 142.96 | 30.38 | 24.05 | 19.88 | 59.01 | 9.64 |
| June 30 | 18.65 | 4.18 | 5.91 | 1.27 | 3.81 | 3.48 |
| July 15 | 11.21 | 5.99 | 2.72 | ..... | ..... | 1.50 |
| July 29 | 10.66 | 4.62 | 3.38 | ..... | ..... | 2.78 |
| September 14 | 8.79 | 3.53 | 2.67 | ..... | ..... | 2.59 |

Little or no attention is given to the division of the stream during the flood season. When, however, the water supply begins to fail, careful discrimination is made between the early and late rights, not only among the canal interests, but among the irrigators under the respective systems. On July 1 both North Bench Canal and Lehi Canal had their supply from Dry Creek shut off, and during the remainder of the season the entire flow of the creek was used in the Alpine district.

## CURRANT OR SALT CREEK.

Salt Creek, as the headwaters of Currant Creek are known, rises in the Juab Valley near the eastern slope of the Mount Nebo Range. From its source it flows in a southwesterly direction and enters Juab Valley near the town of Nephi, the county seat of Juab County. From Nephi the creek takes a northerly course and at the northern end of Juab Valley passes through the Juab range of mountains into Goshen Valley, emptying into Utah Lake about 5 miles north of the town of Goshen.

The main water supply comes from two small creeks—Hop Creek and Rock Springs Creek—which unite about 6 miles east of Nephi. Through Juab Valley the flow of the creek is materially increased from springs and by seepage from the irrigated lands in the vicinity of Nephi. The creek is depleted by diversions made near its entrance into the valley, but is replenished by seepage at the lower end.

### USE OF THE STREAM.

The ditches dependent on Currant Creek for their water supply are small and few. A few individual ditches supply a small area of land in Salt Creek Canyon, while the entire flow of the stream in Juab Valley is controlled by the Nephi Irrigation Company and is distributed to approximately 2,000 acres of land lying in the vicinity of Nephi. The rights of the Nephi Company were acquired in 1860. The association which has controlled the creek since 1860 was incorporated in 1883, under the name of the Nephi Irrigation Company, and at that time its capital stock was placed at $67,500, divided into 2,700 shares at a par value of $25 per share. Water is divided on a pro rata basis and the system of distribution is similar to that of canal systems already described.

There are two other companies interested in the waters of Currant Creek—the Goshen Canal and Irrigation Company and the Mount Nebo Reservoir and Canal Company.

The Goshen Canal and Irrigation Company is composed of the farmers who own land in the vicinity of Goshen, and who have the oldest water rights on the creek, some of which were acquired in 1858 or 1859. This company, together with five individuals owning land near where the creek enters Goshen Valley, controls the entire low-water flow of the creek and uses the water to irrigate 2,000 acres of land in the Goshen district. The company was incorporated in 1877 under the name of the Goshen Canal and Irrigation Company, with a capital stock of $42,000, divided into 1,400 shares at $30 each.

Prior to 1895, the Goshen Company, with the five individuals mentioned, used all the water during the irrigation season, but during the remainder of the year it ran unused into the lake. In 1895 Mount Nebo Irrigation Company was formed and filed on this surplus water for storage purposes. This company agreed to furnish the Goshen Company with the water needed during the irrigation season each year,[a]

[a] The amount of water received by the Goshen Company according to the agreement is here given. Also the method of measuring the amount of water allowed:

| | Inches. |
|---|---|
| January and February, weir measurement | 200 |
| March, weir measurement | 600 |
| April, May, and June, weir measurement | 1,200 |
| July, August, and September, weir measurement | 800 |
| October and November | 700 |
| December | 200 |

"Said water to be measured in weirs in which the water shall be brought to a standstill twenty (20) feet back of discharge opening. The water to flow over a horizontal plate brought to a thin edge and the measurement taken at a stake set ten (10) feet back from the discharge face of weir. Said measurement to show not more than seven (7) inches in depth of water flowing over the weir. The constant quantity to be regulated by a change in width of weir." One cubic foot per second = 57.403 "inches."

in return for which the Goshen Company relinquished its right to the water at other times of the year in favor of the Mount Nebo Company.

In 1895 this company constructed a 30-foot dam[a] at the head of Currant Creek Canyon, in the north end of Juab Valley. The reservoir thus formed has a length of almost 5 miles, an average width of three-fourths of a mile, and a storage capacity of 19,000 acre-feet. Owing to the short water supply since the construction of the reservoir, the greatest volume stored has not exceeded one-half of its capacity.

The stored water is used on the west side of Goshen Valley on 8,000 acres of land 3 to 5 miles west and southwest of Goshen. This land was secured by the Mount Nebo Company in 1894 and 1895.

Water supplied the Goshen district runs down the creek channel 2 miles to a division weir, where it is measured. For the remaining 2 miles of the canyon the water of the Mount Nebo district is carried in an open canal along the side of the canyon for one-third the distance, and for the remainder in a 3-foot semicircular wooden stave flume supported on trestlework. From the mouth of the canyon the canal extends to a short distance west of the settlement of Mount Nebo, where the greater part of the water is used.

The following table gives the discharge of Currant Creek above the reservoir and of the Mount Nebo and Goshen canals, as measured at different times during the season of 1900:

*Discharge of Currant Creek and Mount Nebo and Goshen canals, 1900.*

| Date. | Currant Creek.[a] | Mount Nebo Canal. | Goshen Canal. |
|---|---|---|---|
| | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* |
| June 21 | 20.50 | 18.83 | 21.02 |
| July 6 | 14.74 | 14.41 | 14.60 |
| July 19 | 12.30 | 13.84 | 14.20 |
| August 8 | 14.42 | ..... | 15.02 |
| August 16 | 14.90 | ..... | 15.86 |

[a] Measured at inlet to reservoir one-half mile west of Mona.

During the latter part of July, 1900, the reservoir's supply gave out and the remainder of the season those dependent upon it for irrigation were without water. A movement is now on foot to augment the available supply by artesian wells sunk in the vicinity of the reservoir.

Closely allied with the Goshen Irrigation Company is the Goshen Warm Springs Irrigation and Canal Company, incorporated in March, 1879, for the purpose of diverting and controlling the water of Warm Springs, about 2 miles east of Goshen.

[a] The following facts regarding the Mount Nebo Dam are taken from the Engineering News of December 3, 1896: The dam is 210 feet long at the top, 130 feet at the bottom, and 30 feet in height. Its width at the base is 110 feet and its top width 8 feet. The body of the dam is of selected clay. Its front and back faces are riprapped with loose rock, hand placed. The outlet tunnel is cut through the solid rock of the west abutment of the dam. It is 140 feet long and 6 by 4.5 feet in cross section. The wasteway is cut through the solid rock ridge of the east abutment. The dam and all appurtenances except the wasteway cost about $12,000. The inlet tunnel cost $7.85 per linear foot.

The average discharge from the springs is about 10 cubic feet per second. About 600 acres is irrigated.

## HOBBLE CREEK.

Hobble Creek is a small stream which rises 18 or 20 miles east of Provo City and empties into the eastern end of Utah Lake.

On the headwaters of Hobble Creek, 160 acres are entitled to water under a primary right. The remainder is entitled to water only during the spring flood season. The greater part of the land irrigated from this creek is in the vicinity of Springville, on what is known as Mapleton Bench, southeast of Springville. The ditches supplying this land are small and are managed by the farmers.

The Mapleton Reservoir Canal was built in 1878 for the purpose of filling two small reservoirs. The right of this canal is secondary, which entitles it to water from the creek only during the high-water season. One reservoir was built in 1878, the other in 1900. The capacity of the first is 240 acre-feet; that of the second, 270 acre-feet. They irrigate approximately 150 acres. The ditch and reservoirs are under the control of the municipal corporation of Springville.

The Mapleton Union Canal waters about 2,400 acres on the south side of the creek. It has a primary right to water acquired by appropriation and use in 1853. In 1877 this canal passed into the control of Springville and is managed as a municipal property.

The North Bench Canal irrigates 800 acres northeast of Springville. The water rights are primary and the ditch is owned by an unincorporated company.

In addition to the ditches already mentioned there are three other small ditches which furnish water for an aggregate area of 1,000 acres. All of these ditches have primary rights and are controlled indirectly by Springville.

The rights to the water of Hobble Creek have never been adjudicated and it has been the practice to apportion the stream in accordance with the area irrigated under the small canals. That there has been but very little trouble in making the division on this basis is probably due to the fact that the municipal corporation of Springville controls the greater part of the stream.

The following measurements show the flow of the Hobble Creek canals as measured during the season:

*Discharge of Hobble Creek and the water diverted from it, 1900.*

| Date. | Hobble Creek. | Mapleton Union Canal. | North Bench Canal. | Other Canals. |
|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* |
| May 24 | 38.19 | 17.22 | 7.68 | 13.29 |
| June 19 | 27.08 | 12.32 | 5.76 | 9.00 |
| June 23 | 21.92 | 10.68 | 4.90 | 6.39 |
| July 5 | 18.33 | 8.15 | 3.89 | 6.29 |
| July 13 | 18 | 8.51 | 3.11 | 6.38 |
| July 21 | 18 | 7.48 | 2.58 | 7.94 |
| August 7 | 11.79 | 6.98 | 2.75 | 2.11 |
| August 17 | 16.19 | 7.08 | 2.32 | 6.79 |
| August 31 | 15.07 | 7.24 | 1.75 | 6.08 |

## PAYSON CREEK.

Payson Creek, often called Peteeneet Creek, rises in the mountains about 10 miles southeast of the town of Payson. The creek flows in a northwesterly direction, and enters Utah Lake about 6 miles southwest of Payson. It is controlled by the city of Payson, another instance of municipal control of water used in irrigation. On the headwaters of the creek the city has constructed a number of small storage reservoirs. At the mouth of Payson Creek Canyon is the city's electric plant, which is a source of considerable revenue, and furnishes the inhabitants of the city with light, heat, and power at lower rates than if the plant were a private enterprise.

Payson controls also the water from Spring Lake, located about 3 miles southwest of the city, the average discharge from which during the irrigation season seldom exceeds 2 cubic feet per second. The total area irrigated in the Payson district approximates 1,500 acres.

*Discharge of Payson Creek and Spring Lake, 1900.*

| | Cu. ft. per sec. |
|---|---|
| Payson Creek: | |
| June 22 | 9.93 |
| July 7 | 11.00 |
| July 19 | 9.59 |
| August 1 | 8.40 |
| August 8 | 7.64 |
| August 16 | 6.72 |
| August 29 | 4.98 |
| Spring Lake: | |
| June 22 | 1.97 |
| July 6 | 1.94 |
| July 19 | 1.68 |
| August 1 | 1.79 |
| August 8 | 1.87 |
| August 16 | 1.83 |
| August 30 | 1.89 |

## SANTAQUIN CREEK.

This creek, known also as Summit Creek, rises in the mountains about 8 miles southwest of the town of Santaquin. Flowing thence in a northerly direction, it enters the lake near the mouth of Payson Creek. The entire flow of this creek is controlled by the town corporation of Santaquin. The area irrigated approximates 1,000 acres. The following figures show the discharge of Santaquin Creek when measured in 1900 at the point where it emerges from the mountains:

*Discharge of Santaquin Creek, 1900.*

| | Cu. ft. per sec. |
|---|---|
| June 22 | 9.33 |
| July 6 | 8.94 |
| July 19 | 8.76 |
| August 1 | 7.33 |
| August 8 | 7.59 |
| August 16 | 8.13 |
| August 30 | 7.66 |

## SALEM POND.

Another small water supply in the Utah Lake Valley comes from Salem Pond. It irrigates approximately 1,000 acres, including meadow and pasture land in the vicinity of Salem, and is under the control of the town of Salem.

*Discharge of ditches from Salem Pond, 1900.*

| | Cu. ft. per sec. |
|---|---|
| West ditch: | |
| July 18 | 4.65 |
| July 31 | 4.95 |
| August 9 | 4.40 |
| August 15 | 5.94 |
| August 29 | 4.23 |
| East ditch: | |
| July 18 | 1.40 |
| July 31 | 1.78 |
| August 9 | 2.29 |
| August 15 | 1.07 |
| August 29 | 1.98 |

## EXAMINATION OF RECORDS.

This investigation included an examination of the county records of the various counties surrounding Utah Lake in order to ascertain—

First. The character of the records of claims to water, including the number of claims, total volume claimed, place where claims are recorded, and the ease or difficulty with which their validity could be determined.

Second. The methods by which the amount and character of water rights are adjudicated or finally established, and the accessibility and completeness of the record of such established rights.

Third. Character of litigation over water rights, its cost, the causes therefor, its influence on irrigation development, and the principles established by decisions rendered in cases arising on the various streams of the drainage system.

This work was first taken up in Utah County, and an abstract made from the records on file in the county recorder's office of all the claims to water, lists of established rights, and water certificates found. The judgment records in the county clerk's office were then taken up and abstracts made of all the cases involving water rights which had come up in the district court.

After the inspection of Utah County records was finished attention was turned to those of Wasatch County, and all records relating to the use of water from Provo River were abstracted.

The little that was found on record in these two counties led to the belief that overhauling the records of Juab and Summit counties would be a waste of time; hence the records of those counties were not inspected.

### UTAH COUNTY RECORDS.

In the recorder's office of Utah County the records of claims and rights to water are not kept in a separate volume, as prescribed by law,[a] but are scattered promis-

[a] Sec. 1275, Comp. Laws 1898 of State of Utah, provides that the county recorder shall keep a separate volume in which shall be recorded all rights to water, either vested or accrued, and notices and claims in regard to the appropriation of water.

cuously among the mining records, comprising some twelve volumes. The claims in this record, whether referring to a mineral claim, water for domestic use, the use of a stream for irrigation, milling, or power purposes, or a tract of land for a reservoir or for a mill site, were all indexed under two heads, "Name of locator" or "Name of mining claim." The index alone occupies two large volumes.

In order to find all of the claims to water it was necessary to go through the mining index and make note of every claim which, under the head of "Name of mining claim," was surmised to be a claim to water. After this preliminary examination of the index, and the compilation of a list of "probable" water claims, the records were consulted and abstracts made of all the records which in any way related to the use of water for either domestic, irrigation, power, mining, or milling purposes.

It was found that, all told, there were one hundred and eighty-six records which in some way referred to the use of water in Utah County. Of this number, one hundred and seventy-one were claims to water, the great majority of which referred to unimportant springs and streams in different parts of the county, many of which, from outside knowledge, were found to be abandoned. Eleven transfers of water right were recorded; none of these, however, specified in definite terms the amount of water conveyed, and in only one was the consideration named, and that was the nominal sum of $1. Four "certificates" granted by the water commissioners of Utah County under the law of 1880 (see page 22) were found recorded. These, although of little value in themselves, have served a good purpose in protecting the rights for which they were granted, and will be valuable evidence when the time comes for a final adjudication of rights to water in this section of the State.

The following abstract of these records, classified according to the drainage system or stream with which they are connected, shows the number of claims, transfers, and water certificates that have been recorded on the various streams in Utah County:

*Claims to water in Utah County.*

| Drainage system. | Claims. | Transfers. | Water certificates. |
|---|---|---|---|
| Location unknown | 20 | 2 | 0 |
| Provo River and tributaries | 29 | 5 | 0 |
| Spanish Fork River and tributaries | 14 | 0 | 0 |
| American Fork River and tributaries | 19 | 0 | 1 |
| Dry Creek and tributaries | 11 | 1 | 1 |
| Currant Creek and tributaries | 2 | 0 | 1 |
| Hobble Creek and tributaries | 12 | 1 | 0 |
| Payson Creek and tributaries | 4 | 0 | 0 |
| Santaquin Creek and tributaries | 11 | 2 | 0 |
| Salem Bend and tributaries | 5 | 0 | 0 |
| Jordan River and tributaries | 7 | 0 | 0 |
| Springs in Cedar Valley and tributaries | 20 | 0 | 1 |
| Kimball Creek and tributaries | 17 | 0 | 0 |
| Total | 171 | 11 | 4 |

The weakness and inadequacy of the Utah system is the absence of any record of the rights of the larger and more important interests in the various streams.

Out of the 29 recorded claims to water from Provo River and its tributaries, only 5 refer to the use of the water from the river itself, and of these 3 were found to have been abandoned. The remaining 2 rights were the secondary right of the Blue Cliff Canal Company to 8,000 cubic feet of water per minute, recorded April 13, 1885, and the right of the Telluride Power Transmission Company to the flow of the river for power purposes, recorded April 4, 1897. Aside from these two recorded claims and that of the Alta Canal, to Lower Guard Quarter Springs, recorded in 1887, there is nothing on the records which would prove or disprove the validity of any of the more important canal interests on the lower section of the river. Even Provo City, a municipal corporation of over 6,000 inhabitants, has no record of its right to the water it draws from the Provo. On Spanish Fork River the conditions are the same. Not one of the important rights is recorded. Of the fourteen claims that are recorded, all refer to small unimportant springs and creeks on the upper reaches of the river. On American Fork River, Currant Creek, and the remainder of the smaller streams in the county the conditions are but slightly different from those on Provo and Spanish Fork. On these streams very few of the recognized rights are recorded, and the entire record is composed of claims to small and unimportant springs and streams, which, in the majority of cases, are worded in the following vague terms:

> Notice is hereby given that I ——— ———, do claim and appropriate the waters of ——— Spring (or Creek, as the case may be) and —— acres of land adjoining for irrigation, domestic, mining, and milling purposes.

In very few instances is the location of the spring or stream given definitely, except as being near or within such a distance of some unrecognized landmark, such, for instance, as a mining claim, some person's house, or some similar point of unknown location.

Another noticeable feature of the record is the apparent lack of knowledge in designating the amount of water claimed. In the majority of cases no mention is made of the amount claimed or appropriated. But in those claims where the amount of water is mentioned it is either expressed in portions of the flow of the stream or spring from which the water is claimed, or else in terms which show a misconception on the part of the claimant. For instance, E. H. S., in June, 1891, claimed 50,000,000,000 cubic feet of the water of Utah Lake. Another claimant on November 22, 1899, recorded a right to 100 cubic feet of water per second to be taken from the "George Schuler" claim in a pipe 2 to 8 inches in diameter; even if the larger pipe had been used in conveying the water, the velocity which the water would have had to attain in order to discharge the amount claimed would have been 286 feet per second, while if the smaller pipe had been used, the velocity would have been about twice that of a rifle bullet. In striking contrast to the two foregoing claims is the modest claim of the L. I. Company, on October 23, 1894, to "1,200 cubic inches of the surplus waters of Dry Creek to be used for storage purposes." The following is given as an example of indefiniteness: W. H. B., in 1869, appropriated all waters of "Deckers Hollow" used for irrigation of 10 acres of land; "a quantity of water about 6 inches in width and 6 inches in depth flowing with the fall of the country in low-water season."

## WASATCH COUNTY RECORDS.

All the recorded claims to water and recorded transfers of water in the recorder's office of Wasatch County were found in one volume of the miscellaneous record. In this were 31 claims to water and 7 transfers of water rights. Of the former, 23 were claims to water for irrigation purposes, 3 for power purposes, and 5 for reservoir sites on the headwaters of creeks entering Provo Valley from the east. Of the 7 transfers of water rights, 6 made mention of the consideration, and all specified in general terms the amount of water transferred, viz, entire stream from Cascade Tunnel; one-half stream from Cascade Tunnel; one-half McHenry Creek; surplus water from tunnel No. 2; 200 gallons per minute from tunnel No. 2; one-half interest in McHenry Creek; 2 acres of water from Spring Creek, Provo Valley.

Few, if any, records expressed the amount of water claimed or transferred in definite quantities or gave the acreage of land upon which such water was used. With the exception of four certificates issued by the water commissioners of Wasatch County in 1881, making the following grants, viz:

*Certificates issued by the water commissioners of Wasatch County.*

| Corporation. | Amount of water. | Source. |
|---|---|---|
| | *Acres.* | |
| Wasatch Irrigation Company | 1,500 | Provo River. |
| | 542.5 | Lake Creek. |
| | 250 | Center Creek. |
| Charleston Irrigation Company | 1,118 | Spring Creek and Provo River. |
| Spring Creek Irrigation Company | 1,000 | Spring Creek. |
| Daniels Creek Irrigation Company | 200 | Daniels Creek. |

In a separate volume was found the record of all the water commissioners' certificates that had been granted under the law of 1880. Three hundred and twenty-five of these certificates relate to the use of water from the Provo and its tributaries. All with the exception of the four mentioned above were granted to individual parties and were worded in the following form:

*Certificate of water right, Wasatch County, Utah.*

Number of acres, 18.

WATER COMMISSIONERS' CERTIFICATE, No. 99 } *Midway precinct:*

Awarded to Moroni Gerber, who has made satisfactory proof before us pursuant to an act passed by the legislative assembly of Utah February 20, 1880, pro rata, to the water of Provo River, 2 acres of meadow, primary right; from Snake Creek, 14 acres, farm, secondary right; and 2 acres, town lots, in Midway, primary right.

MARCH 24, 1881.

(Signed) _____.

The majority of the certificates granted to one individual both primary and secondary rights, and also granted the right to use water from more than one source. These rights, without an exception, were expressed in the number of acres to be irrigated and were further defined by the nature of the land, whether farm, meadow, or town lots. The records of Wasatch County have little value in themselves, but

prior to the adjudication (see page 133) of rights made in 1899–1901 they served a good purpose in defining and protecting the rights for which they were granted.

## WATER-RIGHT LITIGATION.

From the examination of the judgment record of the recorder's office of Wasatch County it was found that but two cases in which rights to water were involved had occupied the attention of the court. In Utah County 36 water-right cases have come before the courts since 1889. Prior to this date no record could be found. Several cases in relation to water rights in minor streams were abstracted, but as no new principles were established their discussion is omitted. As the majority of the important cases were taken up in detail in the discussions of Provo, Spanish Fork, and American Fork rivers, brief reference only will be made to some cases which have involved rights on other streams of this section.

### CASES ON CURRANT CREEK.

#### GOSHEN IRRIGATION AND CANAL COMPANY v. CHRISTIAN E. NIELSON.

This was the earliest case found in which the waters of Currant Creek were involved. It was settled by arbitration, the awards of the arbitrators being subsequently confirmed by decree of the court. There were two arbiters, one from Goshen and one from Mona. The question at issue was Nielson's right to irrigate, during the fall and winter months, 60 acres of land in Juab Valley in the vicinity of Mona, and also his right to maintain a dam in the creek at his point of diversion at all seasons of the year. His rights were confirmed.

#### GOSHEN IRRIGATION AND CANAL COMPANY v. WILLIAM ERCANBRACK ET AL.

The second case involving waters of Currant Creek came before the court December, 1889. The Goshen Irrigation and Canal Company brought suit against five individuals owning land near the mouth of Currant Creek Canyon to prevent these parties from diverting more than their share of the creek, and further prayed the court to enter a decree quieting title of parties interested. Defendants failed to appear in the case, and on December 11, 1889, the court rendered a decree granting to plaintiffs the exclusive right to $\frac{4444}{7777}$ of the entire flow of the stream, and to the defendants the remainder or $\frac{3333}{7777}$ of the stream. The acreage of land owned by each party formed the basis of division of the stream.

#### GOSHEN IRRIGATION AND CANAL COMPANY ET AL. v. CHRISTIAN E. NIELSON AND F. A. KEYTE.

In April, 1895, a case involving Currant Creek and Willow Creek Meadow and Half Mile Springs in Juab Valley occupied the attention of the court. The parties to this action were the Goshen Irrigation and Canal Company and eight individuals against Christian E. Nielson and F. A. Keyte.

The issue between plaintiffs and Nielson was the same as decided between them by arbitration in June, 1889. The issue between plaintiffs and Keyte involved the right to the waters of Willow Creek Meadow Springs and Half Mile Springs, as well as a portion of Lower Salt Creek.

On April 5, 1895, the court practically sustained the decision of the arbitrators in the case of the plaintiff and Nielson.

As between plaintiffs and Keyte, the court decided:

The plaintiffs are entitled to the waters of Lower Salt Creek for the months of May, June, July, and August of each and every year. Keyte is entitled to one-half of the rights of said waters for

the months of September, October, November, December, January, February, March, and April of each and every year. Such water to be taken from the Willow Creek Meadow Springs as "he has used and appropriated said waters for some years last past." Keyte is also entitled to the use of one-third of the waters of Half Mile Springs at all seasons of the year. Each party shall use the water as decreed, without let or hindrance from the other.

## CASES ON HOBBLE CREEK.

### SMITH v. PHILIPS.

This case involves the waters of Roundy Springs, which arise within the corporate limits of Springville, and flow thence naturally into Dry Creek. Plaintiff and fifty individuals claiming to have appropriated and used since 1859 or 1860 "all the water" of Dry Creek, brought suit against Philips and several others, who claimed to have used continuously and without molestation all the flow from Roundy Springs since 1859.

On May 29, 1889, the court decreed that defendant Philips should have the use of "one good irrigating stream of water out of Dry Creek sixty hours out of every sixteen days," and that his use thereof should be regulated accordingly by the water master of Springville. Provision was also made that, in case of drought or general diminution of the water supply, defendant's rights should be adjusted upon the basis of one-fourth of such rights accruing in 1874, one-half in 1879, and the remaining one-fourth in 1882, and only in cases where other water users, whose appropriations date from the same or prior time, are cut off from the use of water on account of short water supply, should defendant's use of water be cut off.

Soon after this decision was rendered the case was taken on appeal to the supreme court of the State, and this tribunal reversed the decision of the lower court, and remanded the case for new trial. (23 Pac., 932.) In rendering its decision the court held that a decree of the lower court giving defendant "one good irrigating stream for sixty hours in every sixteen days, to be measured out and distributed to him and his use thereof regulated by the water master," was void for its uncertainty; and, further, that "the statute does not affix to the term 'irrigating stream' a definite and certain meaning, and we have not been referred to anything of which this court can take judicial knowledge that does."

On May 18, 1891, in accordance with the decision of the supreme court, a new decree was rendered by the lower court in which the awards were stated in definite terms. That part of the decree apportioning the flow of the stream is as follows:

> That the defendant is entitled in the future to use all the waters from the Roundy Springs * * * three days out of every twenty-one days, from the 1st day of May to the 1st day of October; and it is further adjudged that he commence to exercise this right on the 1st day of May of each year at 12 o'clock noon of said day, and continue until the 4th day of May at noon, and exercise it next again commencing on the 22d day of May at 12 noon, continuing for three days thereafter, and so on, at like intervals and for like periods of time until the 1st day of October of each year, and that the defendant be enjoined against and forbidden to use said waters at any other time or times between the 1st of May and the 1st of October in each year, and that each party be at liberty to apply to the court as he shall be advised on any subject relating to the execution of this decree.

### SPRINGVILLE v. HOLLEY.

The question at issue in this case was one as to defendant Holley's right to use certain water from Bartholemew Creek, a tributary of Hobble Creek, for the irri-

gation of 160 acres of land located in Hobble Creek Canyon, about 10 miles east of Springville.

The terms of the decree, rendered also on May 29, 1889, are strikingly similar to those in the case of Smith *v.* Philips, previously mentioned, and were reversed by the higher court for the same reason. (23 Pac., 933.) A new decree, rendered May 16, 1891, granted to Holley the use of "forty inches of the waters of Bartholemew Creek, measured under a pressure or head of five inches," for five consecutive days out of every twenty days, this amount of water to be measured at defendant's point of diversion, and his use thereof to be regulated and controlled by the water master of Springville, who, under the terms of the decree, was appointed a commissioner to so regulate defendant's use. It was further decreed that plaintiff was entitled to all waters of Bartholemew Creek except the portion awarded to plaintiff as given above.

SPRINGVILLE *v.* BURT.

This case is similar to the one just described, viz, Springville *v.* Holley. Defendant, Burt, owned 133 acres of land near the mouth of Hobble Creek Canyon, and was dependent upon certain springs situated on the north bank of the creek for water for irrigation. Defendant claimed to have appropriated water of the springs in 1852 and used their waters continuously from that time up to the commencement of the suit, with the exception of two years, 1869 and 1870, which years he deemed it unsafe to remain on his place on account of Indian troubles. He further claimed that by expending means and labor he had increased the flow of these springs materially.

On May 14, 1890, the court, by common consent of the parties interested, decreed that defendant, Burt, was entitled to the use of all the waters of Burt's Springs, situated on the north bank of Hobble Creek, up to June 1. From June 1 to the end of the irrigation season he was entitled to the use of the entire flow of the springs four days out of every seven, plaintiff being entitled after June 4 to the flow of the springs the remaining three days out of every seven.

## CONCLUSIONS.

From the facts disclosed by the inspection of the county records in both Utah and Wasatch counties, the following conclusions have been drawn:

First. That only a very small percentage of the recognized water rights have been recorded.

Second. That the majority of the water rights that are recorded relate, in the most instances, to small and unimportant springs scattered over the drainage basin.

Third. That the entire record is indefinite.

Fourth. That there is no means of determining the validity of any recorded claim from the records themselves. In several instances duplicate claims were found, and no reference whatever made whereby the rightful claimant could be identified.

Fifth. That the provisions of the State law for recording water rights are wholly inadequate to meet the existing conditions.

Sixth. That the ecclesiastical courts have done much to simplify troubles over water rights and on some streams have dictated the basis of final adjudication.

Seventh. That the decrees of the courts in water cases have, in the majority of cases, tended toward a just settlement of the question at issue, and that in cases where incorrect decisions have been made it has been due to the lack of proper evidence.

# THE SPANISH FORK RIVER IRRIGATION SYSTEM.

By A. F. Doremus.

## INTRODUCTION.

This system comprises a watershed area of about 445,000 acres, the Spanish Fork River with all its tributaries, six principal or diverting canals, two subordinate or branch canals, several minor upstream ditches, and about 75 miles of distributing channels. The irrigated area is about 27,600 acres. (Pl. IX, fig. 1.) The watershed area is part of the westerly slope of the Wasatch Range. It is located southeast of and about 60 miles from Salt Lake. The surface is diversified by peaks and ridges, rough and scantily clad; recesses from which issue streams; gentle slopes, completely clothed; open, fir-fringed parks; and broad bottoms, bordered by shrubbery. The highest point is about 10,000 feet, the lowest about 4,800 feet, above the sea.

Thistle and Soldiers Summit, both within the watershed area, are stations of the United States Weather Bureau, where the precipitation for the year 1900 was as follows:

*Precipitation at Thistle and Soldiers Summit, 1900.*

| Month. | Thistle. | Soldiers Summit. | Month. | Thistle. | Soldiers Summit. |
|---|---|---|---|---|---|
| | *Inches.* | *Inches.* | | *Inches.* | *Inches.* |
| January | 0.90 | 0.60 | August | 0.46 | 0.39 |
| February | .47 | 1.80 | September | 1 | .20 |
| March | .00 | .30 | October | .75 | .20 |
| April | 1.77 | .49 | November | 1.80 | a 1.50 |
| May | .05 | T. | December | .30 | a .20 |
| June | .10 | .00 | Total | 7.10 | 5.83 |
| July | .10 | .25 | | | |

a Approximate.

With the exception of comparatively small portions which border the streams, none of the watershed area is cultivated, but it is used largely, during the summer, for grazing. Sheep tread much of the surface into a hard, smooth crust, involving the grass roots and humus, destroy much of the browse and underbrush, and girdle some species of shrubs and trees, causing great damage. Innumerable channels of varying size ramify the entire area, and into and through these the water is collected and conveyed to the principal canyon where the river is formed.

The Spanish Fork River is a typical stream of this region, with its alternate seasons of flood and failure. Its principal tributaries are the South or Thistle, the North or Diamond, and the Main or Soldier forks. The discharge of these branches, as measured September 18, 1900, was as follows:

| *Discharge of headwaters of Spanish Fork River.* | Cu. ft. per sec. |
|---|---|
| Thistle | 24.64 |
| Diamond | 9.83 |
| Soldier | 9.05 |

The river flows into Utah Lake, a body of fresh water, and thence through Jordan River into Great Salt Lake. From its remotest source to its mouth in Utah Lake the river is not more than 45 miles long, and in this distance it falls about 3,000 feet. About three-fourths of its length is in the mountains. Its mean discharge, as measured from June 8 to October 31, 1900, inclusive, was as follows:

*Discharge of Spanish Fork River at mouth of canyon, 1900.*

| | Cu. ft. per sec. |
|---|---|
| June | 126.5 |
| July | 54.1 |
| August | 50.7 |
| September | 58.9 |
| October | 60.6 |

In ordinary years the volume is said to be at least twice as great as for the same season of this year, and at the flood stage five or six times as great. Between irrigation seasons practically all of the river, and, during flood season the greater part of it, is discharged into Utah Lake. At other times it is all diverted by the canals.

## THE CANALS.

The six principal diversions from Spanish Fork River are known locally as East Bench Canal, Salem Canal, Malcolm Ditch, Mill Race, South Field Canal, and Lake Shore Canal. These are all situated below the mouth of the canyon, and, with respect to direction down the river, in the order named. The East Bench, Malcolm, and Mill Race divert water from the right bank, and the Salem, South Field, and Lake Shore from the left bank of the river. The distance between the head gates of the first and last named canals is about 7 miles along the course of the river. The difference in elevation between the two head gates is about 300 feet, the upper one being about 4,800 feet above sea level. Along the banks of these canals it is customary to plant trees, which serve for shade and firewood. (Pl. X, fig. 1.) Measurements of the water flowing into the several canals, taken in the summer of 1900, are shown in the following table:

*Discharge of Spanish Fork River Canals, 1900.*

| Date. | East Bench. | Salem. | Malcolm. | Mill Race. | South Field. | Lake Shore. |
|---|---|---|---|---|---|---|
| | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* | *Cu. ft. per sec.* |
| May 24 | 13.72 | 28.62 | 10 | 76 | 40.33 | 20 |
| June 23 | 5.64 | 15.66 | 4 | 36.67 | 23.35 | ..... |
| July 5 | 4.30 | 11.14 | 3 | 28.84 | 16.07 | ..... |
| July 18 | 4.68 | 8.84 | 6 | 26.67 | 14.11 | ..... |
| July 20 | ..... | ..... | ..... | ..... | ..... | 5.26 |
| July 24 | 5.80 | 9.32 | 4 | 25.03 | 16.14 | 4.98 |
| July 31 | 4.16 | 8.75 | 0 | 24.70 | 13.60 | ..... |
| August 1 | ..... | ..... | ..... | ..... | ..... | 3.84 |
| August 7 | 2.80 | 8.66 | 0 | 23.03 | 13.90 | 3.91 |
| August 17 | 3.96 | 7.14 | ..... | 24.70 | 17.07 | 4.23 |
| August 31 | 3.01 | 8.66 | 4.68 | 24.72 | 14.35 | 3.47 |
| September 7 | 3 | 6.75 | 4 | 23 | 12.50 | 3.25 |

These canals are owned and operated by the users of the water. Their construction was largely accomplished through labor performed by individual subscribers to stock, in payment of assessments levied for construction purposes. The cost of operation and maintenance is paid from annual assessments. The subordinate canals of the system are the West Field and the Southeast Field ditches, both branches of the Mill Race. The upstream ditches are those which divert water from the river above the mouth of the canyon onto lands which fringe the main stream or its tributaries.

## APPORTIONMENT OF WATER.

It is assumed by the users that their respective rights to water have all been determined. The entire river when at or below the stage of normal flow is considered as containing 24 shares, of which the East Bench Canal is entitled to 2; the Salem, 4; Mill Race, 11; the South Field, 6; and the Lake Shore, 1. All water in excess of the 24 shares is considered flood or surplus water. When the river fails to furnish a normal supply for each of the canals the supply is prorated. Diversion into canals is accomplished by means of timber dams placed across the river channel. (Pl. X, fig. 2.)

Each canal is provided with a head gate and an overflow for regulating the water. There is also a timber sill across each canal some distance below the head gate. Over these sills the water is measured. The length of the sill in feet corresponds to the number of shares or parts of the river to which each canal is entitled. Each canal is under the direct control of a water master, whose duty it is to see that his canal is receiving its proper share and that the water is rightly subdivided among the subordinate ditches and allotted by time and turn to the respective users. These water masters make occasional joint visits to the head gates of all the canals, starting at the lowest, and measure the depth on each sill, and on their return regulate the head gates so as to effect an equal depth of water on all the sills. When this has been done it is assumed that a proper division of the water has been made. The following is a copy of the record of such measurements for the year 1900:

*Depth of water on sills as measured by canal water masters, 1900.*

| Date. | East Bench. | Salem. | Mill Race. | South Field. | Lake Shore. |
|---|---|---|---|---|---|
| | *Inches.* | *Inches.* | *Inches.* | *Inches.* | *Inches.* |
| May 16 | 22 | 17 | 16 | 17.50 | 15.75 |
| May 24 | 15 | 13.50 | 15.75 | 13.50 | 11.25 |
| May 29 | 17.75 | 13 | 12.75 | 13.50 | 12.25 |
| June 1 | 12.75 | 12.75 | 12.75 | 13.25 | ..... |
| June 12 | 11.75 | 10.50 | 10.25 | 10 | ..... |
| June 24 | 7 | 9.50 | 9.50 | 9.50 | ..... |
| June 28 | 4.25 | 7.50 | 6.75 | 6.75 | ..... |

These canals have appropriated all the water of the river except what belongs to Utah Lake and the small quantity diverted by the upstream ditches. While they are now recognized as the original canals, they were not the first to divert water from the river, although they are considered equal in right. Several individual ditches were made in 1851 and afterwards abandoned. In 1856 a ditch built by the Government

took water from the left bank of the river to irrigate an Indian farm on the Spanish Fork Reservation. Both ditch and reservation have long since been abandoned.

## THE IRRIGATED AREA.

The irrigated area is situated in Utah Lake Valley and extends along both sides of the river from the mouth of the canyon to the shore of the lake. The surface is generally smooth and slopes gradually toward the northwest. The area embraces all varieties of soil from loose gravel to compact clay. The higher portions contain the gravel. Between the gravel and clay are sandy and clayey loams. None, however, has natural moisture enough to make it productive. Originally sagebrush, greasewood, bunch grass, and a few scattering cottonwoods fringing the river were all that the soil produced. When provided with a full supply of water, wonderful productivity resulted.

The principal divisions of the irrigated area are belts or zones which lie one above another on the common slope, the several canals serving as boundaries. The canal lying along the upper margin of each supplies water to the belt immediately below. The following table shows the area of each of these belts:

*Area under each canal.*

| Name of canal. | Acres. | Name of canal. | Acres. |
|---|---|---|---|
| East Bench | 4,500 | South Field | 3,500 |
| Salem | 2,200 | Lake Shore | 3,640 |
| Malcolm | 125 | Total | 27,600 |
| Mill Race | 13,635 | | |

These belts are subdivided into tracts of from 5 to 80 acres each, with here and there a town site having lots of about an acre each. The people as a rule have their homes in towns, the farms being from 1 to 5 miles away. The home and the farm are connected by broad shady roadways. The largest town is Spanish Fork, with a population of 3,327. There are three smaller towns—Salem, having 894 inhabitants, Benjamin 661, and Lake Shore 582. Each town has its public hall, stores, and school and church buildings. Some have street lights, waterworks, telephone exchange, telegraph, and other common conveniences. The management of common property, including canals, is participated in by all the people through vote, according to the number of shares held by each. Two lines of standard-gauge steam railways—the Oregon Short Line and the Rio Grande Western—cross the area. Several flour mills derive power from the canals. The water, after passing through the mills, is used for irrigation. In like manner light and heat are produced without diminishing the value of the water for irrigation.

Both soil and climate are well adapted to the raising of fruits, vegetables, grain, sugar beets, alfalfa, and, in fact, all products of the temperate zone. Originally the principal crops raised were wheat, oats, and barley, all maturing early in the season, the growing period being from ninety to one hundred and twenty days. The crops now raised are more varied, and some, as alfalfa, grow vigorously for a period of two hundred or more days. The grain lands have been largely seeded to alfalfa,

FIG. 1.—VIEW OF IRRIGATED LANDS ALONG SPANISH FORK RIVER.

FIG. 2.—WHEN THE WATER SUPPLY FAILS.

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FIG. 1.—CANAL SCENE ON SPANISH FORK RIVER.

FIG. 2.—DAM AT HEAD OF LAKE SHORE CANAL, SPANISH FORK RIVER.

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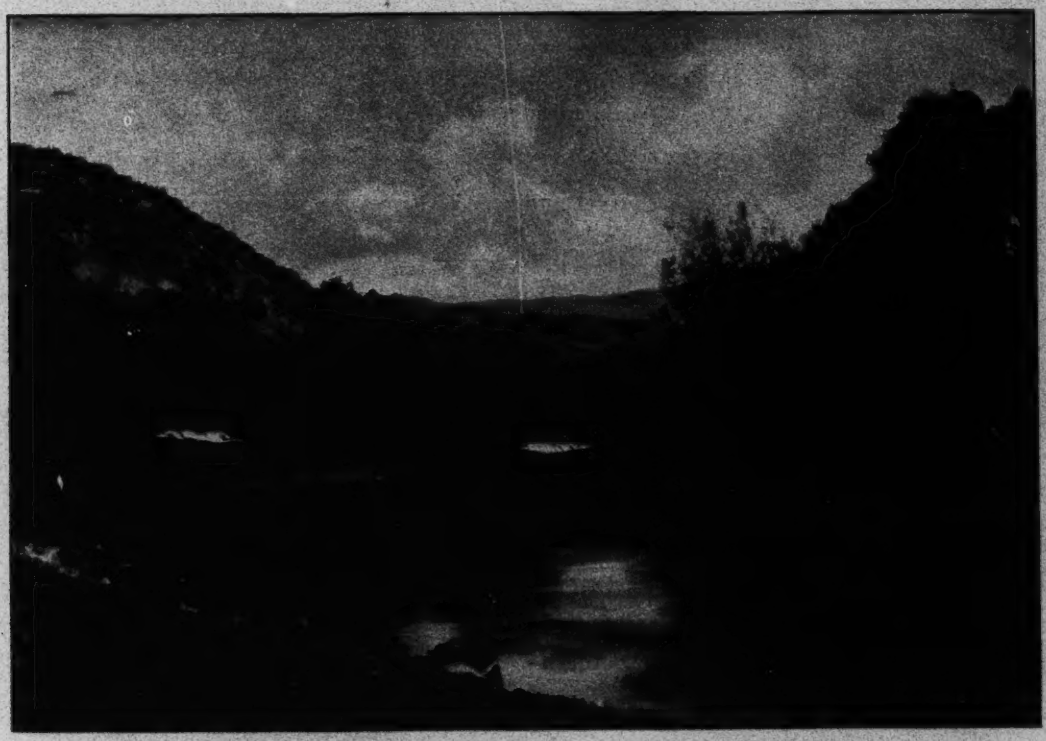

FIG. 1.—DAM SITE AT MOUTH OF LITTLE DIAMOND CREEK.

FIG. 2.—DAM SITE AT NARROWS, SPANISH FORK RIVER.

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which is now the leading crop. Sugar beets and grain are next in order of importance. With plenty of water 6 to 8 tons of alfalfa, 14 to 24 tons of sugar beets, or 30 to 60 bushels of grain are harvested from one acre.

The irrigation season begins about the first of June. The season terminates when the sugar-beet crop has matured and the third crop of alfalfa is well advanced, usually about the last of September. The irrigation season may begin April 1 if drought is feared.

The season of 1900 was most unfavorable to farming under irrigation. The early spring rise of the stream, due to melting snow in the lower portions of the watershed, occurred at the usual time (March), but was much below that of ordinary seasons with respect to both volume and duration. The June rise, from the snow in the higher portions of the watershed, swelled the stream but little, if any. This condition was plainly foreseen early in the season, and preliminary flooding, practiced to some extent each year, was begun on the higher lands and alfalfa fields as soon as the frost had left the ground. It is generally agreed among water users that the supply for the year 1900 was barely one-half that of ordinary years. This is confirmed by the United States Weather Bureau reports. The midsummer flow, it is claimed, was but about one-third of that for the same period of ordinary years. This was due partly to failure of the customary June rise, and, in a measure, to the reduced volume returned to the river through seepage.

The following canal measurements show that from July 5 to September 7, inclusive, there was flowing onto the irrigated area an average daily volume of 63.6 cubic feet of water per second:

*Discharge of canals taking water from Spanish Fork River.*

| Name of canal. | Cubic feet per second. | Name of canal. | Cubic feet per second. |
|---|---|---|---|
| East Bench | 4.2 | South Field | 15.2 |
| Salem | 9.7 | Lake Shore | 4.4 |
| Malcolm | 3.2 | Total | 63.6 |
| Mill Race | 26.9 | | |

This is the equivalent of 8,174.4 acre-feet, and would cover the entire area to a depth of 0.3 foot. During the same period the river, as shown by the table of discharge, supplied an average of 51.4 cubic feet per second, the equivalent of 6,624.5 acre-feet, or sufficient to cover the entire area to a depth of 0.24 foot. The difference between the volume measured in the river and that measured in the canals represents the volume returned to the river channel through seepage. No facts as to the actual area irrigated were obtained, but assuming that 25 per cent of the whole area is occupied by canals, ditches, roadways, waste lands, buildings, stack and barn yards, it is evident that the remaining area must have been inadequately watered during these sixty-five days of midsummer or that the larger part of it was wholly unirrigated.

The annual discharge of the river for years of normal rainfall is approximately three times the discharge during the irrigation season. The surplus is either employed during the preliminary irrigation season—sometimes to disadvantage—or runs to waste. There are no reservoirs connected with the system, although the

water courses contain several suitable sites for the construction of dams for impounding water. One of these is in the North or Diamond Fork, just below the mouth of Little Diamond Creek, where a dam 50 to 125 feet in height would make available the capacious basin above. (Pl. XI, fig. 1.) In the Narrows, a rocky contraction in the canyon several miles above Little Diamond Creek, a dam 150 feet high would form a double basin in the two forks of the canyon immediately above. (Pl. XI, fig. 2.) Other means for conserving the water supply could be employed. The numerous gentle slopes of the area might be saturated with water diverted from the streams during times of plenty, to be yielded back to the river through seepage later in the season. The same slopes might also be gradually planted with timber to aid in conserving the moisture absorbed from both the melting snow and the applied water. During the coldest weather banks of ice might be formed by flooding suitably situated flats, to act as contributors to the succeeding summer flow.

## WATER RIGHTS.

Throughout the State water is considered personal property, and may be sold independently of the land. The use of water may be, and frequently is, transferred from one piece of land to another under the same canal. This may be done to accommodate the water user who has two pieces of land situated some distance apart, on one of which the water may be used one season and on the other the next season. Water may also be transferred through lease or by actual sale from one user to another. Under certain restrictions water may be transferred from one canal into another. It must be admitted that where this practice is sanctioned by law there is opportunity for ownership or control by syndicates and combines, although experience so far has developed no such tendency. The transfers frequently made are of small rights and to bona fide water users. No general fear exists that a continuance of the practice will ever result in dangerous or oppressive ownership or control. In many instances operations under this law have proved the very opposite of detrimental, as, for example, where the use of water has been changed from irrigation to mining. Had such change been prohibited by law, the mine that afterwards proved of more benefit than the abandoned farm could not have been developed, and would have been lost to the Commonwealth. But the opportunity for the water lord exists, and he may yet be evolved through the operations of this law.

### CONDITIONS LEADING TO THE DECREE OF APRIL 20, 1899.

The popular assumption that all rights to the use of water from Spanish Fork River have been settled is based on a decree of the fourth judicial district court of this State, filed at Provo City, April 20, 1899. The decree purports to apportion all the water of the river and its tributaries according to the respective rights of all the users. The following is a brief review of the causes which led to the decree:

The older and principal appropriations of water were made according to the then prevailing custom of constructing a canal and turning water into it. There was no requirement of law or custom that made posting notice, recording, defining, or other similar preliminary action necessary. Diverting the water constituted the sole act which accomplished the appropriation. The right was not fixed by specific volume of

water, area to be irrigated, length of period in which the water was to be used, nor by any other limitations except the undetermined maximum capacity of the canal, and this might be and often was extended by enlarging the canal. If the volume of water diverted was more than necessary to serve the original purpose, the excess was not turned out at the head, but was allowed to flow through the canal, and was regarded as appropriated water. If the volume diverted was not continuously used on the land, it was kept in the canal, and was subject to application on the land at any time and for any period that the appropriator might elect. Water was turned out of the canals only during short intervals when the canals were being cleaned or during times of extreme cold to avoid the effects of freezing. So long as the river supplied water in excess of that diverted, a condition of enviable contentment and development prevailed. No defect in the method of appropriation nor thought of the consequent contention was even suggested. But the time came when all the water known as the normal flow was diverted. Such of the normal flow as was not utilized, but flowed back into the river, was discharged, together with the flood water, into Utah Lake.

Under a similar custom of appropriation, undefined and unrecorded rights were being simultaneously acquired by parties who diverted the lake water from Jordan River, which is the only outlet of the lake. Then followed similar indefinite appropriations of the flood water, known as surplus water. These were made by diverting the water through new canals onto the higher lands and through enlargements of the older ditches onto additional lands adjoining those first irrigated. At the same time, rights to store undefined portions of the surplus water in Utah Lake were being acquired by the users below. Expansion continued. No one stopped to consider whether the limit had been reached or whether it had been exceeded. All were intent upon the present. Then followed a season of deficient snowfall, and the river failed to furnish a volume equal to the customary diversions. That all could not enjoy the usual supply was evident. How should the inevitable be met? Public meetings were held; the situation was discussed; concessions were made. The water was finally apportioned irrespective of right, for the purpose of equalizing the loss over the entire system. The result was that, while the general loss was considerable, the individual loss was inappreciable. The work of expansion was, however, checked. The question of rights was born and took form in contention over what constituted "primary" and what "surplus" rights. Division of the water users into two classes soon followed. One class, consisting of those who had made appropriations of the normal flow, designated themselves primary owners, and, contending that the normal stage of the river had been reached, undertook to deprive those whom they designated surplus owners of a further supply of water until the river should again exceed in volume the normal stage. In the absence of definite knowledge as to what constituted the volume at the stage of normal flow, there was no lack of ground for dispute. The defects in method of appropriation became alarmingly apparent. Had each appropriation been for a fixed volume and time, and had public record been made of the evidence of these, together with the date of diversion, the rights in the stream at normal or at any other designated stage of flow could easily have been determined. This had not been done and retribution was at hand. Then it was that one class, contending that the surplus water had been exhausted and that,

as appropriators of the normal flow, they were entitled to the whole stream, would proceed in force and shut off the supply from those whom they regarded as belonging to the other class. These, insisting that there was still surplus water in the stream, would retaliate by restoring their supply, with a little added, as soon as the first force had retired. Thus was inaugurated a war which has continued to the present time, and which is typical of the strife that exists among water users throughout the State, involving a measureless expenditure of time and money, limitless ill will, and often human life itself.

The general disposition and advice was to settle the question out of court, and accordingly church officials and boards of arbitration were called upon to hear and decide the questions as they arose. Little permanent good resulted from these procedures, as no decision was binding save on such interests as accepted it. Unanimous assent of all interests was essential to any permanent settlement. This was impossible to procure, and the attempts were accordingly failures. The investigations that were a part of these proceedings dealt largely, in the absence of any written records, with the traditions of each canal, which went to show that some arrayed with the primary owners belonged in the class of surplus owners and that others whose rights had been enlarged from time to time really belonged in both classes. In consequence, subdivisions of the two original classes followed, and matters grew worse instead of better. The existence of a right was freely admitted. The extent of a right was bitterly disputed. All rights were vague to the point of being indescribable. To complicate, if possible, the already intricate matter, most of the original rights had been modified through acquiescence in divisions of the water according to agreements for prorating former deficiencies or rules promulgated by a board of churchmen or arbitrators. The water was being divided in a tentative manner, tolerated because no better plan could be agreed upon. The question was further entangled by efforts to make new appropriations. Although it was generally understood that there was no more available water, the uncertainty surrounding existing claims gave ground for hope that all who made a claim would ultimately have a right. Little would be lost, much might be gained.

One season of deficient snowfall was succeeded by another, and a corresponding decrease in the volume of the river followed. The situation became unbearable, and the courts were finally appealed to. How the courts were to establish definite rights upon the foundation of indefinite and intricate claims was not explained. Perhaps it was never questioned even by the courts, and the attempt was not made. The first decision did not settle the question, and other actions followed. Each case seems to have developed cause for other suits, and one action succeeded another until about a score had been tried. Then came the case which resulted in the decree previously mentioned, and which is popularly relied on as conclusive.

### PROVISIONS OF THE DECREE.

The decree apportions all the water of Spanish Fork River and its tributaries among five of the principal diverting canals of the system, to wit, East Bench, Salem, Mill Race, South Field, and Lake Shore, and forty-five individuals who are supposed to represent all the "upstream ditches" of the system. The decree recites that these

canals "being five in number, are all the canals and all the diversions of water from the Spanish Fork River below the mouth of Spanish Fork Canyon."

The normal flow of the river is fixed by that volume which is in the river when the water is "15½ inches in depth by 24 feet in width." At this stage the water users "above the mouth of said canyon are not entitled to any of the water of said river, except for the irrigation of 30 acres of land, so long as the volume of the river continues at or below said stage." The water that is decreed for irrigating this 30 acres, as measured by the terms of the decree, is "such quantity as is used for irrigating the same number of acres of land at the same season of the year under the canals below the mouth of the canyon." Water rights to these 30 acres "are to be known, as designated in this decree, as primary right," and are awarded as follows:

*Rights to water from Spanish Fork River above mouth of canyon.*

| | Acres. |
|---|---|
| Emma Gardner | 20 |
| Henry Gardner | 3 |
| Hyrum Siler | 4 |
| William Rawlins | 3 |

Below the mouth of the canyon the normal flow is awarded, as appears below, in parts of the whole stream:

*Rights to water from Spanish Fork River below mouth of canyon.*

| | Parts. |
|---|---|
| East Bench | 1/24 |
| Salem | 4/24 |
| South Field | 6/24 |
| Mill Race | 11/24 |
| Lake Shore | 1/24 |

The real intent as to the Lake Shore Canal is not made clear, as will appear from the following clause, copied from the decree:

That so long as the waters of said river continue at or below said 15½ inches in depth by 24 feet in width, measured as aforesaid, the Lake Shore Canal shall not be entitled to any of the water of said river, except such as may be called seepage water arising below said city dam. (The dam at head of Mill Race.)

Shutting off the supply of normal-flow water at the same time that the surplus rights terminate indicates that Lake Shore Canal was considered as belonging to the surplus class. But while the decree deprives the Lake Shore Canal of the one twenty-fourth part of the river apportioned to that canal before the stage of normal flow has been reached, it does not permit the other canals to take the water, neither does it say what disposition shall be made of the share so shut off. Later, however, when the river has fallen to a given stage below the normal flow, the decree provides, substantially, that the share so shut off shall be prorated among the other four canals, as appears by the following clause in the decree:

That whenever the water of said river recedes in volume to a quantity not exceeding 15½ inches in depth by 23 feet in width, measured as aforesaid, the East Bench Canal shall have two twenty-thirds thereof; the Salem Canal four twenty-thirds thereof; the South Field six twenty-thirds thereof, and the Mill Race eleven twenty-thirds thereof.

It is generally conceded that all of the five canals belong to the same primary class, notwithstanding the difference in time of their appropriations. In view of the

obscurity of the decree and of the acknowledged right in the premises, it is customary for the Lake Shore Canal to receive its one twenty-fourth of the whole stream during the interval that the river is receding in volume from a quantity 15½ inches in depth by 24 feet in width to a quantity 15½ inches in depth by 23 feet in width, at which latter time the seepage usually becomes an equivalent for that previously apportioned from the river. In this respect the apportionment is at variance with the decree, although in conformity with common sense and justice. Although the decree makes the Lake Shore Canal supply contingent upon seepage after the stage of normal flow, it is probable that if the seepage should fail this canal would be apportioned one twenty-fourth of the river flow.

The decree then prescribes the manner in which the water shall be apportioned when the volume recedes below the last-named stage of flow, which is, practically, to prorate the supply among the several users of the primary class, exclusive of the Lake Shore Canal, which thereafter depends on seepage for its supply.

The users of the surplus water above the mouth of the canyon are divided into classes designated second and third. At all times when the volume of water in the river is between the stages of 22 inches in depth by 41 feet in width, and 18 inches in depth by 41 feet in width, 2 per cent of the whole stream is awarded for the use of both classes, and is to be apportioned among the several users by acres. At all times when the volume of water in the river is between the stages of 18 inches in depth by 41 feet in width and 15½ inches in depth by 24 feet in width, the third-class rights cease and 1 per cent of the whole stream is awarded to the second-class users, to be apportioned among them by acres.

The use of surplus water below the mouth of the canyon is decreed as follows:

> Until the water of said river recedes in volume to a quantity not exceeding 25 inches in depth by 24 feet in width, measured as aforesaid, each of said parties shall have and be entitled to take of said water according to their necessities.

This stage of river evidently covers the whole period during which the users above the mouth of the canyon are restricted to 2 per cent of the whole stream and part of the period when the second-class rights are restricted to the use of 1 per cent of the whole stream. This in reality constitutes the users of surplus water below the mouth of the canyon a privileged class, who enjoy the right of unrestricted use during the whole period of restricted use by the third class and extending over a portion of the time that the second class is permitted to enjoy restricted use only. In other words, the surplus users below the canyon may take all the water they need, while the supply to surplus users above is wholly shut off or restricted use only permitted. If, during the period when both upper and lower rights are in force, there should not be water to fill the elastic measure of "necessity" below and the fixed measure of "per centum" above, it seems that confusion beyond the power of the decree to correct must ensue. But the surplus users above have also been decreed unrestricted use of the water by a clause which provides that so long as the river and its tributaries shall supply water in excess of the volume that measures 22 inches in depth and 41 feet in width, all who take water above the mouth of the canyon shall be entitled to such portion of the water as is "sufficient for their necessities." This is equivalent to saying that those who take water above the mouth of the canyon may use what water they need at such times as the river furnishes more than

there is other use for, a seemingly unnecessary and gratuitous proceeding in view of the fact that previous custom and present law recognize the right to use unappropriated water.

Finally, the water masters of the five diverting canals and the water master representing the users above the mouth of the canyon are constituted commissioners to distribute the water in accordance with the terms of the decree.

## DEFECTS OF THE DECREE.

So far as appears from the decree or as is shown by the record of apportionment kept by the water masters, the Malcolm Ditch has no right to any of the water from Spanish Fork River, nor has any of the water been apportioned to it. On the contrary, the decree shows that all the water of the river has been awarded to the five canals exclusively and implies that legally there is no Malcolm Ditch. The decree declares that "said canals, being five in number, are all the canals and all the diversions of water and are the only appropriators of any of the waters of said river below the mouth of Spanish Fork Canyon." At the same time it is a notorious fact that the Malcolm Ditch is one of the oldest and best-known ditches on the river, and that for many years before the decree and all the time thereafter this canal has diverted water from the river without restriction as to either time or volume, and greatly in excess, according to the number of acres irrigated, of the proportion allotted to any of the canals or ditches which have rights fixed by the decree. From the tables of area and discharge for each canal it appears that the depth of water applied over the whole irrigated area during the sixty-five days from July 5 to September 7 was only 0.3 foot, the depth applied on the area under the Malcolm Ditch during the same period was 3.29 feet, or more than ten times that of the average depth for the whole system, including the Malcolm Ditch. The fact that this was permitted during a season of unprecedented deficiency in the water supply, when all were contending for their full share of water, suggests the superiority of the right of the Malcolm Ditch notwithstanding the failure of the decree to recognize it. It may be that the Sterling Ditch, which diverts a small stream from the river above the mouth of the canyon, has a similar right. In the face of the declaration of the decree that the five ditches named are the only ones that divert water, and that outside of these there are no appropriations of Spanish Fork River water below the mouth of the canyon, it is not reasonable to attribute the omission of the Malcolm Ditch from the decree to oversight. But whatever the reason may have been, the omission of this and other rights from the decree is none the less unfortunate, because it renders the decree impracticable of enforcement in the face of a popularly conceded right such as that of the Malcolm Ditch. It makes the practice of apportioning the water at variance with the requirements of the decree. One or the other must be wrong, and either the practice or the decree should be corrected.

The decree requires the apportionment of the water to be made by four different methods of measurement—(1) by acres, (2) by the same quantity as for a similar area below, (3) by parts of the whole stream, and (4) by the needs of the water users. No key is provided for determining the common equivalent for these various measures. It is left to the commissioners who are charged with the work of apportioning the water to solve these problems.

It is required by the decree that the volume of water in the river at different stages shall be determined from measurements of the depth and width of the water. The velocity of the water has been utterly ignored, although as essential in determining volume as either depth or width. In this respect the decree would be no les definite if it ignored the width and required that the volume should be determined from its depth and velocity alone. The volume of water at various stages of flow is to be determined by measurements made at a fixed place below the mouth of the canyon. Some of the decreed water is diverted 20 miles above the place of measurement. Compliance with this requirement would, therefore, compel the frequent turning of all the water from users above for such time as it would take the water to flow this 20 miles and be measured, a requirement as impracticable as it is unnecessary and unfair.

The requirement that the water "shall, when 15½ inches in depth by 24 feet in width, weir measurement, be measured at the measuring gates below the mouth of the canyon" has been taken to mean that these gates are not only to mark the place of measurement, but are to be the devices used in measuring and apportioning the water as well, and it has been and still is the practice to so use them, although they are not suitable appliances for such purpose. Just what the words "weir measurement" were intended to mean is a matter of conjecture. By some they are construed to require that the depth in inches and the width in feet must be according to weir measurement. This would of course be ridiculous, even if justified by the phraseology. The intention may have been that the stream, when at the stage of given depth and width on the sills, should be measured by weirs for the purpose of determining the volume. This view would, however, conflict with the repeated declaration of the decree, which fixes the volume by the given depth and width of the stream. It may have been and probably was the intention of the decree that the stream at times of measurement should be of the required depth in inches when passing through a weir having a length of crest equal to the required width of the water in feet. If this was the real purpose, the decree fails to express it in comprehensible terms. It is lame also in having failed to designate the type of weir to be used, there being several types that are used to measure flowing water, no two of which will discharge the same quantity, although having equal lengths of crest and depths of water. But whatever the intention may have been, it is evident that the decree so far as it relates to these measurements was not based on a proper knowledge of the devices and methods necessary for measuring water, and that the difference between a gate and a weir was not understood.

The time during which the awarded water may be used is not fixed in the decree, so the rights decreed are not fully determined and must be correspondingly indefinite. It has, however, been claimed that failure to fix the time is no defect, inasmuch as it is the legal assumption, in the absence of specified time, that reasonable time is the limit. But "reasonable time" as relates to irrigation is not a sufficient limit. The importance of a fixed limit of both time and volume for the awarded water becomes apparent when consideration is given all the water rights in Utah Lake basin which affect the rights decreed. These valuable rights must in the early future compel some action which will determine their extent and incidentally modify the apportionment which the Spanish Fork decree is supposed to have fixed.

## CONCLUSIONS.

In ordinary seasons and under present methods 21¼ acres of the watershed area will provide water for 1 acre of the irrigated area.

The full effect of a decrease in the water supply during the irrigation season may be mitigated by the use of an excess of water during the spring months, but in unknown degree.

The practice of prorating a deficiency in the water supply among all the water users is admirable.

Long-continued irrigation tends to increase the duty of water through a gradual rise in the level of the ground water.

The substitution of alfalfa for grain has largely reduced the duty of water by the greater volume required to produce three crops where formerly but one was grown.

The return of seepage water to the river within the limits of its diversion makes available more water than would otherwise be afforded.

Perfect control of the flow of the water is essential to economical use and greatest development.

All the unused water of the area should be impounded on the watershed area and be released only at such times and in such quantities as the needs of the system require. This necessary work, which should be first carefully planned to the minutest detail, should contemplate public ownership or control of the watershed area and its fullest protection and improvement, with a view to restoring and enlarging the growth of grass, timber, browse, etc., and the maintenance of an untrodden surface. The construction of reservoirs and other works to impound and regulate the water, the improvement of the river channel to reduce or prevent loss from absorption, the abandonment of unnecessary diverting canals and the betterment of those retained, the installation of suitable apportioning devices, must be included in the perfection of the plan. This will require time as well as intelligently directed effort. The interests and agencies that have produced the system in its present state are capable of carrying the work to completion if rightfully protected and encouraged in the undertaking. The very existence of the system depends on the watershed area. It should be under as complete control of the water users as is the irrigated area. No other control can be as effective, because no other interest is so dependent upon it nor does any other interest so fully understand its importance. No other interest should be permitted to impair this vital part of the irrigation system. Nothing can be more destructive of the system than the attempted occupancy of the area by the two antagonistic interests which now seek sustenance upon it. The nomadic interests require consumption of the grass and timber. The domiciliary interests demand preservation of the grass and timber. Under present conditions no two interests could be more conflicting. What is vital to the one is destructive to the other. The situation is really serious. On one side are arrayed the herdsman and his flock, and on the other are the husbandman and the home. If the one is important, the other is indispensable. The future of the system is in the balance, and on the control and use of the watershed area depends whether there shall be progression or retrogression.

The popular view that all the rights to the use of Spanish Fork River have been settled and that the water is being apportioned accordingly is not justified. The fact that the decree relates to but part instead of to all of the rights of the system warrants the assumption that none has been settled. A knowledge that the devices employed in dividing the water are defective, that it is impracticable to apportion part of the water by acres and part by shares, and that the Malcolm Ditch is exempt from regulation, compels the belief that the apportionment is as indefinite as are the rights. It is clear, although not generally understood, that the decree is valueless as a means of pacifying the conflicting claims to the water of Spanish Fork River. It is also apparent that other lawsuits must follow before all claims shall have been covered by decree, and still others before the rights shall have been finally determined. The end of litigation will probably not be accomplished before completion of the course now generally pursued of first decreeing the rights and then correcting the decrees. Legislation competent to make contention unnecessary, and at the same time to provide simple and effective rules for appropriating the remnant of unused water, is most desirable. Such legislation could, perhaps, have no better foundation than the present water laws of Wyoming or of the Northwest Territories of the Dominion of Canada.

## ACKNOWLEDGMENTS.

To Mr. Arthur P. Stover for measurements of flow in river and canals; to Mr. L. C. Kelsey, city engineer of Salt Lake City, for maps; to United States Surveyor-General Anderson, of Utah, for data relative to the watershed area, and to Mr. L. H. Murdock, of the United States Weather Bureau, for precipitation records, acknowledgment is made.

# IRRIGATION IN THE WEBER VALLEY.

By JAY D. STANNARD,
*Assistant in Irrigation Investigations.*

## WEBER RIVER AND ITS WATER SUPPLY.

The source of Weber River is on the northwestern slope of the Uinta Mountain Range, about 75 miles due east of the southern extremity of Great Salt Lake. (Map, Pl. XII.) Four river systems have their sources near this point, clustered about Bald Mountain. Three of them, the Bear, the Weber, and the Provo, discharge their waters into Great Salt Lake. The fourth, Du Chesne River, is a part of the Colorado River system. If a line be drawn connecting source and mouth of Weber River, its length will be 75 miles, and its direction will indicate the general course of the river, as there is but one point where the river is at a greater distance than 8 miles from this line. This occurs in a southerly bend about 2 miles above Peoa, and the distance here between the river and the line mentioned is about 12 miles. The total length of the Weber is about 125 miles, of which about one-half lies in Summit County and 25 miles in Morgan County. It forms the boundary between Davis and Weber counties for about 7 miles of its length, and 30 miles of its lower course lies in Weber County. Of the tributaries of the Weber six deserve mention. Three of these tributaries come from the north—Chalk Creek joins the Weber at Coalville, Echo Creek at Echo, and Lost Creek at Croydon. The three tributaries that flow into the Weber from the south are Beaver Creek, which joins the river about 2 miles above Peoa; Silver Creek, which comes in at Wanship, and East Canyon Creek, which enters about 2 miles below Morgan. The last tributary brings to the Weber, in addition to the natural flow, the waters stored in East Canyon Reservoir.

The area drained by the Weber and its tributaries above the United States gauging station, which is located on the west line of Morgan County and just above Devils Gate, is 1,600 square miles.

The mean monthly flow of Weber River at Devils Gate for the years 1896 and 1897 is as follows:

*Mean monthly flow for 1896 and 1897.*

| | Cu. ft. per sec. |
|---|---|
| January | 384 |
| February | 387 |
| March | 704 |
| April | 1,963 |
| May | 3,592 |
| June | 2,286 |
| July | 356 |
| August | 226 |
| September | 242 |
| October | 410 |
| November | 472 |
| December | 380 |

In 1897, the year having the smaller discharge, 622,064 acre-feet of water passed the gauging station at Devils Gate. This is sufficient to cover the land in the lower valley, that depends upon the Weber for its water supply, to a depth of 36 feet.

The discharge for May and June, in the year 1896, would cover 17,000 acres, the approximate area watered by the river below the gauging station to a depth of 23 feet, while in May and June of 1897 the natural flow of the river would cover it to a depth of 19 feet. To state this fact in another form—if the flow of the Weber during May and June could be fully utilized it would cover more than 60,000 acres of land to a depth of 5 feet. This would permit the entire irrigated area under Weber River to be increased 50 per cent beyond the present limits if this water could be held until needed. The advantages of storage will be discussed later.

## CANALS IN WEBER VALLEY AND LANDS IRRIGATED BY THEM.

Irrigation from Weber River begins between 12 and 15 miles below its source and thence for a distance of 12 miles private ditches are taken out which irrigate 1,305 acres, divided as follows: Marchant & Sons, 600 acres; Mecham, 15; Young, 5; William Wardell, 45; Perry, 10; Stillman, 70; James Wardell, 40; Wilds Brothers, 160; Brinton Company, 160; Stinson, 160; and A. Evans, 40.

The South Fork, a tributary from the south, furnishes water through the Welch Ditch to irrigate 50 acres and through the J. Evans Ditch to irrigate 25 acres. Agricultural operations in this section are confined almost exclusively to raising hay.

About 25 miles below the source the Weber emerges from the upper canyon and flows a little south of west through the first valley of any importance, which contains nearly 5,000 acres. The river divides the irrigated lands into two nearly equal parts. The land on the north side of the river lies in three bodies, locally known as the North Bench, the New Field, and the South Bench. This land is irrigated by means of two ditches. The upper ditch, the North Bench and New Field, is taken from the Weber at the mouth of the upper canyon. It is 12 feet wide at the head, and supplies water for 1,400 acres—883 acres in the North Bench and 517 in the New Field. The South Bench contains nearly 800 acres and is watered by the South Bench Ditch, which heads about 1½ miles below the mouth of the canyon. The land on the south side of the river is known as Kamas Flats. It is watered by four ditches—the Marion, Gibbons, Boulderville, and Richards. The Marion Ditch heads on the left bank of the Weber about one-fourth of a mile below the mouth of the canyon. It furnishes water to nearly 1,300 acres of land; the Gibbons Ditch waters about 800 acres, and is taken from the river through the Marion head gate; the Boulderville Ditch heads about half a mile below the mouth of the canyon and supplies water to about 900 acres of land, and the Richards Ditch is taken out about 1 mile below the canyon and waters about 60 acres.

The general direction of the Weber through this valley is to the southwest, but at a distance of 5 or 6 miles below the canyon the river makes quite an abrupt bend to the northwest. At this bend it receives the water of Beaver Creek, which brings to the river the seepage of the Kamas Flats. Above the mouth of Beaver Creek and below Richards Ditch a number of private ditches are taken from the left bank of the river, watering in the aggregate about 200 acres of land, as follows: Horton Ditch, 50 acres; Miles Ditch, 80 acres; Young Ditch, 60 acres; and Jensen Ditch, 10

acres. Situated in the bend of the river on the right bank, and extending below the mouth of Beaver Creek, is a body of land containing about 400 acres known locally as Sage Bottoms. This is irrigated by a ditch bearing the same name, which heads about half a mile above the mouth of Beaver Creek. About 2 miles below Beaver Creek is the settlement of Peoa, and at this point the river receives a small tributary from the north named Fort Creek, the flow of which comes principally from drainage and seepage from North and South benches and New Field. Numerous springs also rise about Peoa, along the bluffs immediately east of the town and in the bottoms between the town and the river. Fort Creek and the springs mentioned supply water for about 400 acres in and about Peoa.

Rockport, 3½ miles below Peoa, is a settlement situated in a valley on the left bank of the river in which there are about 265 acres irrigated. The water is supplied through a ditch taking the name of the settlement, which heads about a mile and a half above Rockport.

Between Rockport and Wanship, which is 4½ miles below, private ditches supply water for about 200 acres of land located principally on the left bank of the river. A little below Rockport, Pine Creek comes into the river from the north. This stream furnishes water only in the early part of the season and irrigates about 200 acres. East Wanship Ditch No. 1 heads on the right bank of the river about 2 miles above Wanship, and supplies water to a little more than 400 acres. Wanship Ditch No. 2 supplies water to the town of Wanship and in addition furnishes water for the irrigation of about 170 acres of farming land. It is taken from the left bank of the Weber a short distance above the town. The water supply for this ditch was formerly taken from Silver Creek, which comes into the Weber at Wanship. This source, however, was abandoned in 1893 on account of the fouling of the waters of Silver Creek by the mills of Park City.

Silver Creek and the springs near its head furnish water for about 1,000 acres. The befouled waters of the creek are allowed to settle in shallow reservoirs, and when sufficiently cleared the water is drawn off and used principally for irrigating meadows.

Alexanders Creek, a tributary of Silver Creek on the left about 1½ miles above the Weber, supplies water for irrigating about 110 acres of land.

Between Wanship and Coalville, the county seat of Summit County, a distance of about 8 miles, the Weber flows nearly due north. In this valley upon the east side of the river about 1,000 acres are irrigated by means of the Hoytville Ditch No. 1, Rodebach Ditch, and Coalville and Hoytville Ditch. The Brown Ditch irrigates 15 acres and Gunn Ditch 30 acres. In this section the Elkhorn Ditch brings water from the Elkhorn, a tributary of Chalk Creek, to irrigate about 160 acres.

On the west side of the river about 540 acres are irrigated from the Weber River through the West Hoytville Ditch and several private ditches.

At Coalville the Weber receives from the east the waters of Chalk Creek and nearly 2,000 acres are irrigated from this stream. Of this area 780 acres are irrigated from private ditches along the upper course of Chalk Creek and tributaries in the upper valley.

In the lower valley, which is 3½ to 4 miles in length, about 875 acres are irrigated from Chalk Creek. This tract includes 384 acres on the south side of the creek watered by the Upper Robinson, the Lower Robinson, the South Chalk Creek, and

the Coalville City ditches, and 533 acres on the north side watered through the North Narrows, the City Cemetery and Chalk Creek, and the Middle Chalk Creek ditches. Chalk Creek also furnishes water for 256 acres in the Weber Valley below Coalville, which are watered through the North Chalk Creek Ditch. Between Coalville and Echo, a distance of 6 miles, only about 150 acres are irrigated from the Weber, about 90 acres on the left bank of the river through the Calderwood Ditch, and 60 acres on the right bank by means of the Asper and Brim ditches. Grass Creek comes to the Weber from the east about midway between Coalville and Echo. It furnishes water during the early part of the season only, about 60 acres being irrigated from it through the Lawson Ditch and the Williams Ditch. Near the mouth of Grass Creek the direction of the river changes from north to northwest, which course is held for about 11 miles to the mouth of Lost Creek, near Croydon.

One-half mile above the town of Echo the Weber receives from the east the waters of Echo Creek. Echo Canyon is very narrow for a number of miles above Echo and the land in it susceptible of irrigation is limited. In the lower 7 miles three ranchers irrigate a total area of 45 acres through the Chappel, Hayes, and Jones ditches. In the upper valley of Echo Creek about 800 acres are irrigated by means of the Reese, Moore, Ball, and Rathall Sheep Company ditches. Echo City Ditch is taken from Echo Creek about half a mile above the point where the creek flows into Weber River. The water is taken into the valley of the Weber proper and used to irrigate four farms having a total area of 170 acres. From Echo to Henefer, a distance of 4 miles, the valley of the Weber is narrow, and there is no irrigation from the river except near Henefer. On the right bank of the river near this point, 160 acres are watered from the river through the Shill and the Stephens ditches.

The town of Henefer is situated on the left bank of the river, near the upper end of a beautiful valley (Pl. XIII, fig. 1), 1,030 acres of which are irrigated from the Weber through the Henefer Ditch. In addition to this area, about 100 acres are watered from canyon streams, whose flow is limited, except in the early part of the season.

Four miles below Henefer, Lost Creek comes into the Weber from the northeast. Between these two points the river leaves Summit and enters Morgan County. Irrigation in this part of the Weber Valley is limited to Lost Creek and its tributaries. The settlement of Croydon is located near the lower end of the valley of Lost Creek. The irrigated land near it has an area of 424 acres, and is watered from Lost Creek through two ditches, which are the property of the Croydon Irrigation Company, and are known as the Upper and Lower ditches. The waters of Lost Creek are also used for irrigation for a distance of 9 or 10 miles above Croydon. Eleven farms are watered in this section from Lost Creek and its tributaries, having an aggregate area of 515 acres.

From the mouth of Lost Creek to Morgan, a distance of about 8 miles, the course of the river is a little south of west. For three-fourths of that distance the Weber flows through a narrow canyon, with no water taken from it for irrigation. Round Valley, 3 miles above Morgan, contains about 500 acres, which the river divides into two parts, nearly equal in area. These are served by two ditches, the North Round Valley and the South Round Valley ditches, which head in the

canyon just above the valley. Some fine springs rise in this valley, and are utilized for irrigation.

Morgan is located in the upper end of one of the most important valleys on the river, in respect of the extent of the area irrigated and the value of the farm products. The valley of the Weber proper extends from Morgan nearly to Devils Gate, a distance of about 12 miles. At Morgan an arm of the valley extends to the south and includes the lower valley of East Canyon Creek, which is the most important tributary of the Weber above Devils Gate. From all sources in this valley 6,000 acres are irrigated, and of this area nearly one-half, or 2,900 acres, is irrigated from the waters of East Canyon Creek and its principal tributar , Mill or Hardscrabble Creek. This land is supplied through the White, East ] orterville, West Porterville, Musser, Old Fort, East Richville, Richville Mill Race, Velch, and Littleton and Milton ditches. Fourteen hundred acres are irrigated from the Weber directly, through the North Morgan, South Morgan, Morgan City, River Ditch at Peterson, and Lowe and Heiner ditches. A number of fine springs rise in the valleys on the north side of the river a few miles below Morgan. These sprin s furnish a supply of water for about 600 acres. The ditches that serve these lanc are the Robinson-Smith, Grover-Smith, Clawson-Smith, Enterprise, Heiner, and th Steward and Stoddard springs. The remaining 1,100 acres in this valley are irrig ed from creeks that are tributary to the Weber in this section. Those coming from the south are Deep, Line, Smith, Dalton, Peterson, and Jacob creeks. Those on the north side are Cottonwood, Garden, and Strawberry creeks.

At Devils Gate the Weber leaves Morgan County and for about 7 miles forms the county line between Davis and Weber counties. Its course in this section is nearly west. Three miles below Devils Gate the river leaves the lower canyon just above Uinta (Pl. XIII, fig. 2), and its waters are again drawn upon for irrigation. The highest canal in this section is the Davis and Weber Counties Canal. It heads about half a mile above the mouth of the canyon on the left bank of the river. This canal is carried along the bench and bluffs that border the river bottoms on the south and west. It reaches the top of the bench at a distance of 9 miles from the head, and at this point divides into the North, West, and South branches. A small ditch called the Hadlock is taken out of the West Branch near this point. This canal supplies water for nearly 4,000 acres, and, as it is one of the later canals, it is not entitled to water when the flow of the river has reached a minimum. To remedy this shortage the company has built a reservoir in East Canyon, which will be more fully described in another part of this paper, upon which it draws when the natural flow of the river is taken by prior appropriators. The lands in the river bottoms below the mouth of the canyon are watered by a number of smaller ditches, those upon the south side of the river being the Bambrough, the Dunn, the Jones, the South Weber, and the Riverdale. These ditches irrigate in the aggregate nearly 2,300 acres. Upon the north side of the river, within a mile of the mouth of the canyon, two ditches, the Uinta Central and the Pioneer, which furnish water for 350 acres of land in and about the town of Uinta, are taken out. The Pioneer Ditch claims the distinction of being the oldest ditch taken from the Weber, having been built in 1851. The Uinta Central was built the following year.

About 5 miles south of Ogden the Weber leaves the county line of Davis and Weber counties and flows nearly due north to the city of Ogden, where it receives the waters of Ogden River from the east. The Weber below Ogden flows to the northwest 7 or 8 miles, then bends to the southwest and enters Great Salt Lake some 12 miles southwest of the city.

The Weber Canal heads about 3 miles above Ogden, and the mill race for the Riverdale Mill heads about 2 miles above the city. Each of these ditches supplies water for irrigation, the total area watered by them being about 480 acres. At Ogden the Wilson Canal and the Hooper Canal are taken from the left bank of the Weber, the head gates of these canals being about 100 feet apart. These two canals water the lands in the lower valley between Ogden and the Great Salt Lake. The Wilson Canal divides about one-fourth of a mile below the head, and one branch, called the Old Wilson Canal, flumes across the Hooper Canal and waters about 300 acres. The other branch supplies water for 3,076 acres. The Hooper Canal, through its branches, the West Weber, the North, the Muskrat, the West, and the South branches, furnishes water for the irrigation of 8,030 acres.

A number of canals are taken out of the Weber below the mouth of the Ogden. It is not the purpose, however, of the present paper to discuss them in any way.

## RECORDED CLAIMS TO WATER FROM WEBER RIVER AND TRIBUTARIES.

The records of water rights and claims have been made in the several counties in which the ditches are taken from the natural stream or in which the land to be irrigated is located. In order to find these records for the Weber River it was necessary to visit the county seats of four counties, viz, Summit, Morgan, Davis, and Weber. Under the act of 1880 (see page 22) the county commissioners were created ex-officio water commissioners. They were required to measure streams, to determine the average flow of water therein at any season of the year, to hear and determine all claims to water, and to issue certificates showing the right to use water in accordance with their decisions. They also were given power to distribute the water within their respective counties in accordance with the nature and extent of recorded rights and to decide all disputes between parties, filing a copy of their findings with the county recorder. The records of such certificates in the counties in which the Weber is used for irrigation are discussed below.

### SUMMIT COUNTY RECORDS.

An examination of the records of Summit County revealed, recorded under the act of 1880, sixty-four primary rights and eight secondary rights to the waters of Weber River and its tributaries, and to the waters of springs which rise in the watershed of the Weber. Forty-six of these certifiates were issued to individuals, the remainder of the primary rights were issued to groups of individuals, and in most of the cases there was no evidence to show that the men formed a company or an association. The dates of making these claims were from May 2, 1881, to December 6, 1887. There were two, however, of as recent date as June, 1894.

A noticeable feature in these records is the absence of any definite statements whereby one could get an idea of what amount of water was appropriated or what

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WEBER COUNTY

Stoddardville

Uintah

T. 6 N.

OGDEN

WEBER RIVER

GREAT SALT LAKE

WYOMING

UINTAH

FOREST RESERVATION

LAKES

MAP OF THE

# WEBER RIVER DRAINAGE BASIN

SHOWING

CANALS AND IRRIGATED LAND

AND GOVERNMENT, STATE AND PRIVATE

LAND NOT IRRIGATED

## UTAH

LEGEND

- Irrigated land
- Private land not irrigated
- Government land
- State land leased
- Canals
- County boundaries

Scale of miles

0 1 2 3 4 5 6 7 8 9 10

FIG. 1.—VIEW OF WEBER VALLEY ABOVE HENEFER.

FIG. 2.—VIEW OF WEBER VALLEY ABOVE UINTA.

amount of land was irrigated with the water appropriated. In a few cases the number of acres to be irrigated was specified, but no definite description of the land was given. For instance, a primary right was granted to five parties to the use of the waters of Weber River. The land to be irrigated consisted of fields containing 75, 15, 25, 40, and 30 acres, located in sections 29, 32, and 33, township 1 north, of range 5 east, Salt Lake meridian. One of these water certificates granted to the claimant a primary right to water a certain parcel of land described as follows: "Lying on the south side of Chalk Creek, in Upton Precinct, Summit County, Utah."

Other claims to water are found in the Summit County records, but no special book is set aside for them. Fifty-three claims and statements were found scattered through eleven volumes of records, five of these being from the Weber River. One of the five claimed 962 cubic feet per minute to be used for milling and irrigation. Another was made by the Oquirrh Water and Land Company, and claimed 50,000 inches, or 1,000 cubic feet per second, a volume far greater than the discharge of the stream, except during the flood season. Diversion was to be at or near a point where Weber River is separated by a ridge from the "Upper Lake," which empties into Provo River; thence into and through the channel of Provo River, through Utah Lake and Jordan River, to the canal system of the above-named company.

Of the three remaining claims to the Weber, one is for additional water by reason of extension of ditch; another claims a primary right, based on thirty years' use, to water sufficient to irrigate 1,100 acres of land; and the third, in the form of an affidavit, claims all the water that will flow through his ditch, the dimensions of which are given.

Of the remaining recorded claims, 25 are for the waters of creeks tributary to Weber River, 16 are claims to waters flowing from springs, and 7 are for claims to reservoirs. To show the character of these claims, the following are given:

One claim to the waters of "Z" Creek covers all the waters now flowing in said creek and all that will hereafter flow in said creek, and claimant forbids any and all persons appropriating water above point of diversion (which is not described). Another claims, by appropriation and use for more than seven years, all the waters of Hopkin Creek and Dipping Pen Creek. Another claims, by appropriation and use since 1890, all the water flowing in Dipping Corral Canyon, flowing in channel and ditch about 1 foot deep and 3 feet wide, average flow in high water about 250 inches, and describes the land on which the water is used. Another claims to be the owner of certain described tracts of land, and to be entitled to the use of the drainage and overflow from the meadows of parties who are named, and from sundry springs.

F. H. Wright and James Salmon, acting as agents for and in behalf of the city of Coalville, located and made claim to a body of water known as South Fork Lake, together with its tributaries, as a reservoir for storing water for irrigation and other purposes, said lake being on unsurveyed land about 18 miles southeast from Coalville.

Sidney W. Darke claims the waters contained in, or which may be drained into, 56 lakes, which are named, situated near the headwaters of Weber River, and the right of using the waters for the purpose of irrigating any lands that claimant may find necessary or convenient to irrigate with said waters. W. H. Stevens, W. W. Hortin, T. T. Rasmussen, and M. Frazier, certify that Ole G. Olsen, of Oakley,

is associated with them in a company commonly known as the North Bench Ditch Company, which has no articles of incorporation; that Olsen's interest in said ditch is $80 and water sufficient to irrigate 40 acres of land.

### MORGAN COUNTY RECORDS.

In Morgan County there are recorded 247 water-claim certificates granted by the board of county commissioners, under the act of 1880. Of this number 220 are for primary rights and 27 for secondary rights. One hundred and seventy-one of these certificates claim water from all sources to irrigate 5,056½ acres, 963½ acres being irrigated from the Weber, 665½ acres from Loss or Lost Creek, 631½ acres from Deep Creek, 263 acres from Line Creek, 278½ acres from Peterson Creek, and the balance, 518½ acres, to be irrigated from springs and smaller streams. In addition to the area mentioned, the claims include water for irrigation in the towns of Croydon, Morgan, Porterville, and Peterson. The description of the lands irrigated in many cases is not given, and those that are given are indefinite.

The manner of recording claims in Morgan County differs from that practiced in Summit County in this respect. In Morgan County each individual took out his own certificate granting to him the right to water, and if a number are under the same ditch there is nothing in the certificate to indicate that fact. In Summit County a number of individuals joined in one certificate which granted one right and then showed how the total amount of water claimed was divided among them.

A careful search through the records of Morgan County shows that there were 23 claims recorded other than those already mentioned as being recorded under the act of 1880. Of these 9 are for claims to water for irrigation, 7 are records of articles of incorporation, 3 are claims upon the waters of Weber River for power purposes, 1 claims waters of East Canyon Creek for reservoir purposes, 1 certified that notice had been posted, 1 is a court decree, and 1 claims water for transporting cordwood.

Thirty of these claims and certificates represent indefinite quantities of water based upon the flow of a spring or stream without regard to the volume discharged, No. 8 granting two-fifths of the waters of Smith Creek and No. 34 granting five thirty-sixths of the waters of Round Valley Springs; while 1 right is on a time basis—twenty-four hours out of each two hundred and six.

### DAVIS COUNTY RECORDS.

No records showing appropriation of water from the Weber River for irrigation were found in Davis County, and there was but 1 claim for power purposes. This claim was identical with one in the Morgan County record.

### WEBER COUNTY RECORDS.

In Weber County 6 certificates, issued by the board of county commissioners, grant to 58 people primary rights to the waters of Weber River for 1,066 acres. Two certificates grant primary rights to the Hooper and the Wilson canals from the Weber River to "2 by 8 feet of water," and "1 by 8 feet," respectively. One certificate grants a secondary right to Wilson Irrigation Company of 47 square feet from the waters of Weber River. Twenty certificates grant primary rights to the water of

Weber River to 20 people, to be used upon 670 acres in the aggregate. One certificate, under date of October 11, 1880, grants to Charles de la Baume, of Uinta, a primary right for 23 acres in W. ½ of NE. ¼ of sec. 27, T. 5 N., R. 1 W., but does not state the source of supply. The dates when these claims were made are between September 22, 1880, and April 30, 1883. Twenty-one of them state that the water has been used for more than twenty years and 12 of them more than twenty-five years. From these records it does not appear that irrigation was practiced in this valley earlier than 1853.

The above comprise the entire list of certificates issued under the act of 1880. The area covered by these certificates is nearly 13,000 acres, provided the Hooper and Wilson canals irrigated as much land in the early eighties as at present.

The balance of the records of Weber County affecting that portion of Weber River which is covered by this report is very meager. There are 2 claims to the water of Weber River for power purposes, 1 of which was recorded in Morgan County. There are also on record 6 other claims to water which declare the existence and continuous operation of certain canals for definite periods of time without statement as to the volume of water used or area of land irrigated.

These records show that the matter of water rights in the Weber Valley is in a very confused state. Notwithstanding the fact that the earlier records, made under the act of 1880, are considered of no value as giving secure rights to water as claimed, there are more than 1,000 people in the valley who are still relying upon these records and who have no other evidence of title to their rights to water than these certificates. These claims have been recorded for fifteen and twenty years, and they represent rights that have been recognized among the people for forty or forty-five years, and the water has been continuously used during these years for the irrigation of lands in the Weber Valley.

Since 1897 there have been no new appropriations made of the waters of Weber River for irrigation, hence none has been filed for record as having been acquired under the act of 1897. And it seems as if the framers of this law intended to discourage as far as possible the recording of the older claims, as will be seen by reference to the latter part of section 1272: "*Provided*, That a failure to comply with the requirements of this section shall in nowise work a forfeiture of such heretofore acquired rights, or prevent any such claimant from establishing such rights in the courts." If the expression may be allowed, the majority of the people of the Weber Valley are holding their titles to water by "squatter's rights" only.

## WATER-RIGHT DECREES.

We may make two classes of the decrees under which the irrigators of the Weber Valley are holding their rights to the use of water for irrigation. The first class includes those decrees which were made by the agreement of the interested parties themselves; the other class would include those decrees that were rendered by the courts in suits entered into for the purpose of determining the respective rights of the parties. There is another class of irrigators, and a very large one it is, who have no decreed rights to the use of the water. It includes those who have built ditches and appropriated water but have taken no steps to have the right recog-

nized by the proper authorities. When these claims are properly adjudicated the testimony which may be produced may be sufficient to secure primary rights for the appropriators; but they will not be secure in their rights to water till this step has been taken.

The first attempt at an adjudication of water rights of which the writer could obtain any knowledge was made by a conference committee composed of representatives of the several ditch companies of the lower Weber Valley. The investigations prior to this agreement, which formed the basis for the decrees rendered, extended over a period of four or five years. The measurements of the discharges of river and ditches were made by Prof. Samuel Fortier. The decree by this conference committee was given out in January and February, 1896, and recognized rights as follows:

*Rights to water from Weber River.*

| | Cu. ft. per sec. |
|---|---|
| **Bambrough Ditch:** | |
| 1860 | 4.8 |
| 1870 | 4.8 |
| 1872 | 2.4 |
| 1876 | 2.4 |
| | 14.4 |
| **Dunn Ditch:** | |
| 1869 | 5 1/4 |
| 1883 | 6 1/4 |
| 1887 | 2 1/4 |
| | 13 1/4 |
| **Uinta Central Ditch, 1852** | 17 |
| **Pioneer Ditch, 1851** | .7 |
| **South Weber Ditch, 1852** | 17 |
| **Jones Ditch, 1852** | 3.35 |
| | 44.35 |
| **Riverdale Ditch:** | |
| 1851 | 4 1/2 |
| 1856 | 4 |
| 1867 | 2 1/2 |
| 1877 | 4 1/2 |
| | 16 |
| **Wilson Canal:** | |
| April 1, 1853 | 5 1/4 |
| March 15, 1860 | 7 1/4 |
| March 1, 1870 | 74 1/4 |
| | 87 |
| **Hooper Canal:** | |
| April 1, 1853 | 2.28 |
| April 15, 1859 | 4.56 |
| January 2, 1861 | 9 1/4 |
| March 1, 1865 | 46 1/4 |
| February 14, 1867 | 86 1/4 |
| | 149.46 |

It will be interesting to make some comparisons of these decrees with reference to the number of acres irrigated by each. The Uinta Central irrigates 234 acres, and was allowed 17 cubic feet per second by the committee. One cubic foot of water per second irrigates 13.77 acres. The Pioneer Ditch irrigates 120 acres, with 7 cubic feet per second allowed by the committee. Under this ditch 1 cubic foot of water per second irrigates 17.14 acres. The Dunn Ditch irrigates 261 acres, with 13.8 cubic feet per second allowed by the committee. Under this ditch 1 cubic foot of water per second irrigates 18.91 acres. The Bambrough Ditch irrigates 282 acres, with 14.4 cubic feet per second allowed by the committee. In this instance 19.58 acres are irrigatedwith 1 cubic foot of water per second. The Jones Ditch irrigates 100 acres and was decreed 3.35 cubic feet per second. This would permit 29.85 acres to be irrigated with 1 cubic foot per second. The South Weber irrigates 600 acres, and was allowed 17.09 cubic feet per second by the committee. In this case 35.11 acres would be irrigated with 1 cubic foot per second. The Wilson Canal supplies water for 3,381 acres, and was decreed 87 cubic feet per second. Thirty-eight and eighty-six one-hundredths acres are here irrigated with 1 cubic foot per second. The Hooper Canal irrigates 8,030 acres, and was allowed 149.46 cubic feet per second. One cubic foot per second would irrigate 53.73 acres. The Riverdale Canal was allowed 16 cubic feet of water per second with which to irrigate 1,041 acres. One cubic foot of water per second must then irrigate 65.06 acres. If the comparison is made between the Riverdale and the Uinta Central ditches, it will be seen that under the Riverdale Ditch a cubic foot of water per second is expected to cover 4.7 times as much land as a like volume under the Uinta Central.

Two and one-half years later the district court of Weber County adjudicated the water rights of three of the canals whose rights were passed upon by the conference committee as above mentioned. In accordance with the judgment of the court, rendered September 6, 1898, Henry Rolapp, judge, the Riverdale Canal was decreed 18.67 cubic feet per second, a gain of 2.67 cubic feet. The Hooper Canal was decreed 115.01 cubic feet per second, a loss of 34.45 cubic feet; and the Wilson Canal was decreed 90 cubic feet per second, a gain of 3 cubic feet. Based on the assumption that the river discharged enough water to satisfy the agreements of 1896, this suit resulted in a net gain for the benefit of other users amounting to 28.78 cubic feet per second.

The suit that ended in this adjudication was brought by the Hooper and Wilson canal companies against the Riverdale Ditch. The latter ditch company had loaned its water for a number of days to the Davis and Weber Counties Canal. The court held that the Riverdale Ditch had no interest in any water except that in its own ditch, and that the Riverdale Company could not give, sell, or loan the water to another party or company and deliver through a different head gate than its own.

This suit, with the exception of that on Lost Creek, is, so far as the writer could learn, the only one that ended in an adjudication of water claims in the Weber Valley.

It is the duty of the State to provide by statute some inexpensive and effective means for adjudicating these water claims, granting to the people the same security in the use of water as they now enjoy in the use of their land. The need of a final settlement of these vexed questions is being felt more and more as larger areas are

being brought under cultivation and the demand for water is steadily increasing each year.

The adjudication of the water claims under the Weber should be undertaken for the entire valley at once, and not by counties or even smaller areas than counties. This method would make the later claims nearer the headwaters of the streams subordinate to the older claims in the lower valley, instead of being subordinate to the older claims in a certain section of the stream, with no regard to the appropriations and claims in other sections. The adjudication of these claims, some of which are nearly half a century old, will be no easy task, and time will only add to the difficulties, as many of the original appropriators are dead or have moved from the country. For these reasons it will be difficult to arrive at the facts necessary for a just adjudication.

The following table contains a summing up of all the data given in the preceding pages on the ditches from Weber River and its tributaries, the areas served, and the rights to water:

*List of ditches diverting water from Weber River and tributaries.*

| Name of ditch. | Name of stream from which diverted. | Number of acres irrigated. | Volume of water claimed. | Part of stream decreed. |
|---|---|---|---|---|
| Marchant | Moffit and Dry creeks | 600 | All of stream | |
| Meacham | | 15 | | |
| Young | | 5 | | |
| William Wardell | Little Hollow Creek | 45 | All of stream | |
| Perry | | 10 | | |
| Stillman | Dipping Corral Canyon | 70 | | |
| James Wardell | | 40 | | |
| Wilds Brothers | Purdue Creek | 160 | All of stream | |
| Brinton Company | | 160 | | |
| Stinson | Weber | 160 | | |
| A. Evans | do | 40 | | |
| Welch | South Fork of Weber | 80 | | |
| J. Evans | do | 25 | All unappropriated | |
| J. Franson | do | 40 | | |
| Seymour | Weber | 50 | | |
| North Bench and New Field | do | 1,400 | | |
| South Bench | do | 600 | | |
| Marion | do | 1,800 | | |
| Gibbons | do | 200 | | |
| Boulderville | do | 900 | | |
| Richards | do | 60 | | |
| Horton | do | 80 | | |
| Miles | do | 80 | | |
| Young | do | 80 | | |
| Janson | do | 10 | | |
| Sage Bottoms | do | 400 | | |
| Left Bank, Fort Creek | Fort Creek | 124 | | |
| Right Bank, Fort Creek | do | 200 | | |
| Rockport | Weber | 265 | | |
| Wilson | do | 15 | | |
| Peterson | do | 5 | | |
| Vernon and Coney | do | 135 | | |
| Pine Creek | Pine Creek | 200 | | |
| Moore | Weber | 135 | | |
| Young | do | | | |

*List of ditches diverting water from Weber River and tributaries*—Continued.

| Name of ditch. | Name of stream from which diverted. | Number of acres irrigated. | Volume of water claimed. | Part of stream decreed. |
|---|---|---|---|---|
| East Wanship No. 1 | Weber | 400 | | |
| Wanship No. 2 | do | 170 | | |
| Pace Brothers | Silver Creek | 300 | | |
| C. E. Pace | do | 200 | | |
| Homer | do | 200 | | |
| Sweatfield | | 60 | | |
| Bates | Silver and East Canyon creeks | 240 | | |
| Alexanders Creek | Alexanders Creek | 110 | | |
| Hoytville No. 1 | Weber | 407 | | |
| Rodebach | do | 115 | | |
| Coalville and Hoytville | do | 270 | | |
| Brown | do | 15 | | |
| Gunn | do | 30 | | |
| Elkhorn | Elkhorn Creek* | 160 | | |
| West Hoytville | Weber | 270 | | |
| McMichael | do | 80 | | |
| John Wilkinson | do | 80 | | |
| Mills | do | 40 | | |
| Joseph Wilkinson | do | 40 | | |
| Lawson | do | 27 | | |
| Rigby | Chalk Creek | 60 | | |
| W. Clark | do | 8 | | |
| H. Clark | do | 10 | | |
| Powell | do | 20 | | |
| Deming | do | 6 | | |
| M. T. Staley | do | 146 | | |
| Staley-Banner | do | 19 | | |
| C. Staley | do | 15 | | |
| Boyer | do | 115 | | |
| Huff Creek | Huff Creek | 115 | | |
| Thaxton | Chalk Creek | 15 | | |
| J. Clark | do | 20 | | |
| F. Clark | do | 10 | | |
| Judd | do | 25 | | |
| Fewks | do | 80 | | |
| Blondquist | do | 80 | | |
| Smith | South Fork Chalk Creek | 80 | | |
| Steel | do | | | |
| Read | do | | | |
| Salmon | do | | | |
| Swanson | do | 20 | | |
| Blondquist-Huffman | do | 85 | | |
| North Narrows | Chalk Creek | 191 | | |
| City Cemetery and Chalk Creek | do | 238 | | |
| Upper Robinson | do | 142 | | |
| Lower Robinson | do | | | |
| Middle Chalk Creek | do | 112 | | |
| South Chalk Creek | do | 87 | | |
| North Chalk Creek | do | 264 | | |
| Coalville City Ditch | do | 94 | | |
| Calderwood | Weber | 90 | | |
| Asper | do | 80 | | |
| Brim | do | 15 | | |
| Lawson | Grass Creek | 20 | | |

*Elkhorn Creek is a tributary of South Fork of Chalk Creek.

*List of ditches diverting water from Weber River and tributaries*—Continued.

| Name of ditch. | Name of stream from which diverted. | Number of acres irrigated. | Volume of water claimed. | Part of stream decreed. |
|---|---|---|---|---|
| Williams | Grass Creek | 80 | | |
| Moore | Echo Creek | 350 | | |
| Ball | do | 800 | | |
| Reese | do | | | |
| Rathall Sheep Company | do | 200 | | |
| Chappel | do | 7 | | |
| Hayes | do | 7 | | |
| Jones | do | 30 | | |
| Echo City | do | 170 | | |
| Hensfer | Weber | 1,100 | | |
| Shill | do | 40 | | |
| Stephens | do | 120 | | |
| Eddington | Lost Creek a | 40 | | ½ of 0.35 |
| W. H. Toone | do | 75 | | |
| Chas. Turner | do | 20 | | ½ of .35 |
| Geo. H. Wilde | do | 50 | | |
| L. L. and G. B. Toone | do | 80 | | ½ of .35 |
| G. R. Thackery | Cedar Canyon a | 25 | | ½ of .35 |
| J. S. Hopkin | do | 25 | | |
| Kennedy | Lost Creek a | 70 | | ½ of .35 |
| Molé | do | 140 | | ½ of .35 |
| Corydon Irrigation Company | do | 475 | | .65 |
| North Round Valley | Weber | 250 | | |
| South Round Valley | do | 250 | | |
| North Morgan | do | 432 | | |
| South Morgan | do | 302 | | |
| Morgan City | do | 802 | | |
| Lowe and Heiner | do | | | |
| Robinson-Smith | Slough from Weber | 62 | | |
| Clawson-Smith | do | 129 | | |
| Enterprise | do | 340 | | |
| Heiner | do | | | |
| Steward and Stoddard | Steward and Stoddard Springs | | | |
| White | East Canyon Creek | 5 | | |
| East Porterville | do | 320 | | |
| West Porterville | Hardscrabble Creek | 582 | | |
| Musser | do | 196 | | |
| Old Fort | do | 29 | | |
| East Richville | East Canyon Creek | 282 | | |
| Richville Mill Race | do | 611 | | |
| Welch | do | 139 | | |
| Littleton and Milton | do | 665 | | |
| North Milton | Line Creek | 461 | | |
| Deep Creek | Deep Creek | 362 | | |
| Smith Creek | Smith Creek | | | |
| Dalton Creek | Dalton Creek | 202 | | |
| River | Weber | 136 | | |
| Bohman | do | 190 | | |

a The decrees on Lost Creek are in force during the low-water season of each year, which commences at the discretion of the Croydon Irrigation Company. During the times of unusual low-water season, W. H. Toone, David Eddington, J. S. Hopkin, and G. R. Thackery are entitled to one-third of the portion of the waters to which Charles Turner and George Wilde are otherwise entitled.

*List of ditches diverting water from Weber River and tributaries—Continued.*

| Name of ditch. | Name of stream from which diverted. | Number of acres irrigated. | Volume of water claimed. | Part of stream decreed. |
|---|---|---|---|---|
| Cottonwood | Cottonwood Creek | 275 | | |
| Peterson | Peterson Creek | | | |
| Jacob | Jacob Creek | | | |
| Ford | Garden Creek | | | |
| Robinson | do | | | |
| Do | Strawberry Creek | | | |
| Davis and Weber counties | Weber | 4,000 | | |
| Bambrough | do | 282 | 14.40 | |
| Dunn | do | 261 | 13.80 | |
| Uinta Central | do | 234 | 17 | |
| Pioneer | do | 120 | 7 | |
| Jones | do | 160 | 8.35 | |
| South Weber | do | 600 | 17 | |
| Riverdale | do | 1,041 | 18.67 | 18.67 |
| Weber | do | 235 | | |
| Wilson | do | 3,381 | 90 | 90 |
| Hooper | do | 8,060 | 115.01 | 115.01 |
| Total | | 18,569 | | |

## DISTRIBUTION OF WATER FROM THE RIVER.

The Weber River is subject to heavy floods during the spring and early summer. The maximum flood discharge is nearly 8,000 cubic feet of water per second. It is perhaps owing to the heavy pressure which would thus be brought against a dam that there has been no attempt to put in permanent structures. All are of a temporary character, built of bowlders and brush, often made tight with straw or coarse manure, anchored by means of wire or ropes to the trees or rocks along the bank, structures that can be repaired or entirely rebuilt after the high water is past with little labor or expense, thus answering the demand of the season.

The head gates of the canals along the Weber River are, with few exceptions, of the same temporary character as the dams, and there are many ditches with no head gates whatever. The flow of water in the ditch is regulated to some extent by piling rock across the head of the ditch when it is desired to shut off a portion of the water. The main thought, however, is to permit the water to enter the ditch and not keep it out. One of the best types of head gate found on the river is that of the Hooper Canal. This is built with stone abutments, and has a double set of gates placed about 4 feet apart. It has a heavy screen of planks placed above the gates to protect them from driftwood.

The lack of all system in the distribution of water from the natural streams is a very noticeable feature in the irrigation practice in Utah. The experience of the past two or three years has impressed upon the mind of the irrigator that something must be done, and that very quickly, in order to bring relief.

In the past the supply of water which Weber River brought to the irrigators of the lower valley was sufficient for all demands that could be made upon it. Canal managers were accustomed to the sight of large volumes of water rolling past their head gates, and on down to Great Salt Lake. There had always been enough for all, and each ditch owner had only to go to the river and take what he wanted. That

there could ever be a condition different from that which he had always known never entered his mind. Under these circumstances it is a matter of no surprise that old customs still prevail, and there is no person on the stream whose duty it is to see that each canal is taking the amount of water to which it is entitled, and no more. Thus each ditch officer becomes a law unto himself, manipulating not only the head gates of the canal of which he is in charge, but often assisting in the management of others that, in his opinion, are drawing more water than they are entitled to. In 1900 the dam at the head gate of one canal was torn out three times by officers of other ditches who thought that the ditch in question was getting more than its share of the water. They doubtless considered the course pursued the only one by which their rights could be secured. One exception to this condition may be found on Lost Creek, in Morgan County, which will be more fully described in another part of this paper. In order to carry out a decree of the court in the matter of distribution of water among the various claimants, a commissioner was appointed by the court whose duty it was to enforce the provision of the decree.

In order to determine the basis upon which the distribution of the water of Weber River depended, the writer made a number of measurements of the water flowing in the various ditches in the lower valley. Gauge rods were placed in the ditches near the heads in each case. In this way a check was kept on the quantities of water used by each ditch. The gauge rods were put in place July 16, 17, and 20, and the readings were kept until September 1. The results of these measurements are shown in the table following. The names of the ditches are arranged in the order in which they occur on the stream. The first six canals head within 2 miles of the mouth of the canyon. The Riverdale heads about 4 miles below the mouth of the canyon, and the two lower ditches head about 15 miles below the mouth of the canyon.

*Decrees and distribution of water.*

| Name of canal. | Decree. | | Measurement of flow. | | | Total area under ditch. | Area served by 1 cubic foot per second. | Area to be served by 1 cubic foot per second of decreed amount. |
|---|---|---|---|---|---|---|---|---|
| | By court. | By agreement. | Date. | Amount. | Percentage of amount decreed. | | | |
| | *Cu. ft. per sec.* | *Cu. ft. per sec.* | 1900. | *Cu. ft. per sec.* | *Per cent.* | *Acres.* | *Acres.* | *Acres.* |
| Bambrough | | 14.40 | July 16 | 2.49 | 17.3 | 282 | 113.25 | 19.59 |
| | | | July 31 | 2.54 | 17.6 | | 111.02 | |
| | | | Aug. 14 | 3.26 | 22.8 | | 86.96 | |
| Dunn | | 13.80 | July 16 | 1.20 | 8.7 | 261 | 217.50 | 18.91 |
| | | | July 31 | 1.96 | 14.1 | | 133.16 | |
| | | | Aug. 14 | 3.93 | 28.5 | | 66.41 | |
| Uinta Central | | 17 | July 16 | 15.79 | 92.9 | 234 | 14.82 | 13.77 |
| | | | July 31 | 14.01 | 82.4 | | 16.70 | |
| | | | Aug. 13 | 19.58 | 115.2 | | 11.95 | |
| Pioneer | | 7 | July 17 | 8.51 | 121.6 | 120 | 14.10 | 17.14 |
| | | | July 31 | 4.23 | 60.4 | | 28.37 | |
| | | | Aug. 13 | 4.45 | 63.6 | | 26.97 | |
| Jones | | 3.35 | July 17 | .92 | 27.5 | 100 | 108.69 | 29.85 |
| | | | July 31 | 2.35 | 70.2 | | 42.55 | |
| | | | Aug. 13 | 3.62 | 108.1 | | 27.62 | |

*Decrees and distribution of water*—Continued.

| Name of canal. | Decree. | | Measurement of flow. | | | Total area under ditch. | Area served by 1 cubic foot per second. | Area to be served by 1 cubic foot per second of decreed amount. |
|---|---|---|---|---|---|---|---|---|
| | By court. | By agreement. | Date. | Amount. | Percentage of amount decreed. | | | |
| | *Cu. ft. per sec.* | *Cu. ft. per sec.* | 1900. | *Cu. ft. per sec.* | *Per cent.* | *Acres.* | *Acres.* | *Acres.* |
| South Weber | | 17.09 | July 17 | 9.55 | 55.9 | 600 | 62.83 | 35.11 |
| | | | July 31 | 5.28 | 30.9 | | 113.64 | |
| | | | Aug. 13 | 7.22 | 42.2 | | 83.10 | |
| Riverdale | 18.67 | 16 | July 17 | 16.25 | 87 | 1,041 | 64.06 | 55.76 |
| | | | July 31 | 13.54 | 72.5 | | 76.88 | |
| | | | Aug. 13 | 18.68 | 100 | | 55.73 | |
| Wilson | 90 | 87 | July 20 | 3.59 | 4 | 3,381 | 941.78 | 37.57 |
| | | | July 31 | 3.05 | 3.4 | | 1,108.52 | |
| | | | Aug. 13 | 4.08 | 4.5 | | 828.67 | |
| Hooper | 115.01 | 149.46 | July 20 | 13.99 | 12.2 | 8,090 | 573.96 | 69.82 |
| | | | July 31 | 6.68 | 5.7 | | 1,202.10 | |
| | | | Aug. 13 | 8.45 | 7.3 | | 950.30 | |

The table shows that the Bambrough Ditch during this period was drawing from 17.3 to 22.8 per cent of the amount that was decreed it; the Dunn Ditch was drawing from 8.7 to 28.5 per cent of the amount agreed upon; the Uinta Central was drawing from 82.4 to 115.2 per cent; the Pioneer, from 60.4 to 121.6 per cent; the Jones, from 27.5 to 108.1 per cent; the South Weber, from 30.9 to 55 per cent; the Riverdale, from 72.5 to 100 per cent of the amount decreed by the court; the Wilson and the Hooper, from 3.4 to 4.5 and 5.7 to 12.2 per cent, respectively, of the amounts decreed by the court.

The condition clearly shows the weakness of the system. In times of scarcity of water, when the most rigid economy in the use of water should be enforced, and when the greatest care should be exercised in its just and equitable division, it should be impossible for one ditch to take nearly one-fourth more water than it claims as its just share, while another can by reason of its location on the river get less than 4 per cent of its decreed amount.

The table also shows that some of the ditches that were located higher on the river not only used water, but insisted on drawing the full amount of their appropriation, while those ditches that were not so favorably situated could draw but one-thirtieth to one-eighth of the amount to which they were entitled when the upper ditches were drawing their full amount.

The head gates of the Wilson and Hooper canals are located within 100 feet of each other, and no water flowed past the head gate of the Hooper Canal during the period from July 16 to September 1. In view of this condition, cold comfort only is brought by the fact that the law declares that there can be no priority of right among those who hold primary rights. To make a still further comparison of the facts which may gleaned from the table given above, we may show the number of acre-feet of water which was applied to the land under the various ditches during the period between July 16 and September 1.

*Amount of water used by ditches and depth to which the land would be covered.*

| Name of canal. | Area watered. | Quantity used. | Depth. |
|---|---|---|---|
| | *Acres.* | *Acre-feet.* | *Feet.* |
| Davis and Weber | 4,000 | a2,819 | 0.70 |
| Bambrough | 282 | 266 | .94 |
| Dunn | 261 | 215 | .82 |
| Uinta Central | 254 | 1,399 | 5.50 |
| Pioneer | 120 | 478 | 3.98 |
| Jones | 100 | 286 | 2.86 |
| South Weber | 600 | 638 | 1.06 |
| Riverdale | 1,041 | 1,333 | 1.23 |
| Wilson | 3,381 | 326 | .09 |
| Hooper | 8,000 | 886 | .11 |

a Drawn from East Canyon Reservoir.

The one exception to the almost universal practice of allowing the officers of each ditch to go to the stream and take what water was desired was found on Lost Creek. As the result of a friendly suit a decree was rendered which provides for the division of the water, giving to each party a definite portion of the stream after its discharge falls below a certain point. This point, as fixed by the decree, is "when the water of said stream is so reduced in volume that there is not enough water at the mouth or head of the plaintiff's (Croydon Irrigation Company) upper ditch to supply the reasonable necessities of said company." After rendering this decree the cour appointed a commissioner to divide the water among the claimants.

## DIVISION OF WATER UNDER DITCHES.

The irrigators of Utah early learned the value of a sufficient stream of water for economy in irrigation. It has been the practice under many of the ditches to divide the water in times of scarcity by a well-planned time schedule. This gives a comparatively large stream of water to each irrigator whenever his turn comes. In practice this is found to give much better results than to divide the water into small streams and allow these to flow continuously to the several irrigators. This system has given such general satisfaction that the time schedule is used year after year with little change.

The Bambrough Ditch supplies water to the land of 16 persons. There seems to be no relation between the number of shares that one may own and the number of acres which he irrigates. In times of normal water supply a person is entitled to the use of the entire flow of the ditch for a period of three hours for each share. In times of low water the period of time allowed for one share is shortened. The following is the time schedule from 6 p. m. on July 18, to 6 p. m. on July 23, 1900:

*Time schedule, Bambrough Ditch.*

| Name. | Number of acres. | Number of shares. | Number of hours. | Begin. | | End. | |
|---|---|---|---|---|---|---|---|
| | | | | Time. | Day. | Time. | Day. |
| A. B. Cook | 3 | 2 | 3 | 6 p. m. | 18 | 9 p. m. | 18 |
| J. H. Cook | 15 | 8 | 12 | 9 p. m. | 18 | 9 a. m. | 19 |
| Arthur Firth | 12 | 8 | 12 | 9 a. m. | 19 | 9 p. m. | 19 |
| Frank Bowman | 3 | 2 | 3 | 9 p. m. | 19 | Midnight. | 19-20 |
| Robert Byram | 35 | 10 | 15 | Midnight. | 19-20 | 3 p. m. | 20 |
| John Jones | 10 | 8 | 12 | 3 p. m. | 20 | 3 a. m. | 21 |
| Charles Poll | 20 | 4 | 6 | 3 a. m. | 21 | 9 a. m. | 21 |
| John Walton | 20 | 8 | 44 | 9 a. m. | 21 | 1.30 p. m. | 21 |
| John Allen | 4 | 1 | 14 | 1.30 p. m. | 21 | 3 p. m. | 21 |
| Matthew Bambrough | 14 | 4 | 6 | 3 p. m. | 21 | 9 p. m. | 21 |
| Joseph Bambrough | 20 | 8 | 12 | 9 p. m. | 21 | 9 a. m. | 22 |
| George Firth | 28 | 8 | 12 | 9 a. m. | 22 | 9 p. m. | 22 |
| George Stark | 30 | 4 | 6 | 9 p. m. | 22 | 3 a. m. | 23 |
| Charles Schmals | 6 | 2 | 3 | 3 a. m. | 23 | 6 a. m. | 23 |
| Charles Fernelius | 20 | 4 | 6 | 6 a. m. | 23 | 12 m. | 23 |
| Mrs. Charles Fernelius | 30 | 4 | 6 | 12 m. | 23 | 6 p. m. | 23 |

This schedule provides for the use of water once in five days by each irrigator. Each uses the entire flow of the ditch except in cases of high water. When the ditch delivers more water than can be handled by one irrigator, two or three may then use water at the same time.

It will be seen that the time allowed by this schedule for the irrigation of 1 acre varies from twelve to seventy-two minutes, thus permitting one irrigator to use six times as much water per acre as another. This is permitted because of the fact, as stated above, that a person's interest in the ditch and in the water supplied is no measured by the number of acres to be irrigated but by the number of shares which the person may own in the ditch. Again, it will be noticed that the schedule provides for using the water during the night. By the arrangement shown, four of the sixteen irrigators begin irrigating at 9 p. m., one begins at midnight, and two begin at 3 a. m. It is a matter of popular belief among these irrigators that water used at night is more effective than that used in the daytime on account of the greater evaporation during the day. For this reason they do not make much objection to handling the water during the night.

The interest in the Dunn Ditch is divided into eight shares. Each share entitles its owner to use the water for twenty-four hours and the entire flow of the ditch is used by each during that period. This schedule permits each irrigator to have the use of water once in eight days.

The water in the Pioneer Ditch is divided into one hundred shares. Each share entitles its owner to the use of the entire flow of the ditch for one hour and forty-one minutes. Under this plan seven days are required to irrigate all the lands under the ditch.

The South Weber Ditch supplies water to 600 acres of land. It is divided into sixteen shares. One share does not represent the water necessary for any definite number of acres. No time schedule is used under the ditch. Each irrigator has a small constant stream of water flowing to his farm.

The shares in the Riverdale Ditch are based upon the cost of construction. The cost as given by the secretary, W. C. Parker, is $5,666.60, and each share represents $50 of this amount. There seems to be no definite relation between the number of shares owned and the number of acres irrigated, and the water is distributed to the irrigators pro rata according to the number of shares each has in the ditch.

### DAVIS AND WEBER COUNTIES CANAL.

For the division of water among the branches of the canal the Davis and Weber Counties Canal Company has adopted the rectangular weir. Usually at the points of diversion the stream is divided into two unequal parts. A portion of the stream falls over a weir placed at right angles to the flow of the stream; the other portion falls over a weir placed along the side of the stream. The crests of these two weirs are placed at the same elevation and at right angles to each other. It was thought that the flow over these weirs would be proportional to their lengths, and that the division would be simple and accurate. This would be the case had the proper care been exercised in the construction of the weirs. The formula for the flow of water over a weir presupposes that the water falls over the weir from practically dead water, but in practice the water is not brought to a standstill and the weir across the channel discharges more in proportion to its length than the one in the side of the channel.

Crude methods for the measurement and division of water may be permitted when water is abundant, but in times of scarcity of water irrigators will demand measurements which may be relied upon as being approximately correct, as each irrigator wishes to know that he is receiving no less than his rightful share of the water.

### SEEPAGE MEASUREMENTS ON WEBER RIVER.

During the last half of August the writer, in company with Mr. W. M. Bostaph, of Ogden, and Mr. Jesse M. Smith and Mr. D. D. Dibble, of Layton, made a series of measurements of Weber River to determine the amount gained by seepage. The measurements were commenced at Ogden on August 13, and were continued up the river to the mouth of the canyon above Oakley, in Summit County. Measurements were made of all ditches which took water from the river and of all the streams flowing into the river. Measurements were also made of the river at various points along its course.

Another object which was held in view in making this trip was the collection of information concerning the ditches. An effort was made to see the officers of the various ditch companies and obtain from them a list of the names and addresses of those using water, with the number of acres irrigated. The value of these measurements as showing the gain or loss from seepage is not so great as it might have been had the measurements been made continuously, without stopping to gather data concerning the ditches and irrigated area, or if the work had begun at the head and continued downstream. However, measurements were made at a season when the flow of the river was subject to very little fluctuation, and there was at this time very little change in the quantity of water which was being taken from the river by

the different canals. These facts favor the seepage measurements and add to their value. The results as given below are arranged as though the measurements were commenced at the highest point on the river and carried down.

*Seepage measurements, Weber River, August 13–23, 1900.*

[Cubic feet per second.]

| | | |
|---|---|---|
| **First section:** | | |
| Inflow—River in canyon above Oakley | | 62.11 |
| Outflow from section— | | |
| New Field and North Bench Ditch | 18.26 | |
| Marion Ditch | 13.11 | |
| Boulderville Ditch | 11.24 | |
| South Bend Ditch | 3.81 | |
| Sage Bottom Ditch | 3.99 | |
| River above Beaver Creek | 3.13 | |
| | | 53.54 |
| Loss in section | | 8.57 |
| **Second section:** | | |
| Inflow— | | |
| River above Beaver Creek | 3.13 | |
| Beaver Creek | 29.48 | |
| | | 32.61 |
| Outflow— | | |
| Rockport Ditch | 3.99 | |
| River below Rockport Ditch | 49.97 | |
| | | 53.96 |
| Gain in section | | 21.35 |
| **Third section:** | | |
| Inflow— | | |
| River below Rockport Ditch | 49.97 | |
| Chalk Creek | 1.20 | |
| | | 51.17 |
| Outflow— | | |
| Wanship Ditch No. 2 | 3.73 | |
| Wanship Ditch No. 1 | 3.78 | |
| E. R. Young Ditch | .23 | |
| Hoytville Ditch No. 1 | 19.60 | |
| West Hoytville Ditch | 4.35 | |
| Coalville and Hoytville Ditch | 2.70 | |
| River below Chalk Creek | 39.60 | |
| | | 73.99 |
| Gain in section | | 22.82 |
| **Fourth section:** | | |
| Inflow— | | |
| River below Chalk Creek | 39.60 | |
| Echo Creek | 1.09 | |
| | | 40.69 |
| Outflow—River below Echo Creek | | 38.78 |
| Loss in section | | 1.91 |

*Seepage measurements, Weber River, August 13–28, 1900*—Continued.

[Cubic feet per second.]

| | | |
|---|---|---|
| Fifth section: | | |
| Inflow—River below Echo Creek | | 38.78 |
| Outflow— | | |
| Henefer Ditch | 22.53 | |
| John Shill Ditch | 1.83 | |
| River below Henefer Bridge | 23.75 | |
| | | 48.11 |
| Gain in section | | 9.33 |
| Sixth section: | | |
| Inflow—River below Henefer Bridge | | 23.75 |
| Outflow— | | |
| Stephens Ditch | 4.66 | |
| River above mouth of Lost Creek | 26.25 | |
| | | 30.91 |
| Gain in section | | 7.16 |
| Seventh section: | | |
| Inflow— | | |
| River above mouth of Lost Creek | 26.25 | |
| Lost Creek | 12.03 | |
| | | 38.28 |
| Outflow— | | |
| North Round Valley Ditch | 5.32 | |
| South Round Valley Ditch | 3.86 | |
| River above Morgan | 39.19 | |
| | | 48.37 |
| Gain in section | | 10.09 |
| Eighth section: | | |
| Inflow—River above Morgan | | 39.19 |
| Outflow— | | |
| North Morgan Ditch | 3.80 | |
| Morgan City Ditch | 12.30 | |
| Weber Ditch, Morgan | 12.35 | |
| Morgan Mill Ditch | 11.78 | |
| Paulson and Extram Ditch | 2.11 | |
| River 600 feet above mouth of East Canyon Creek | 21.73 | |
| | | 64.07 |
| Gain in section | | 24.88 |
| Ninth section: | | |
| Inflow— | | |
| River 600 feet above mouth of East Canyon Creek | 21.73 | |
| East Canyon Creek | 38.19 | |
| | | 59.92 |
| Outflow—River 300 feet below mouth of East Canyon Creek | | 60.19 |
| Gain in section | | .27 |

*Seepage measurements, Weber River, August 15–23, 1900*—Continued.

[Cubic feet per second.]

| | | |
|---|---|---|
| **Tenth section:** | | |
| Inflow—River 300 feet below mouth of East Canyon Creek | | 60.19 |
| Outflow— | | |
| River Ditch, Peterson | 9.65 | |
| Bohman Ditch | .25 | |
| River below Bohman Ditch | 95.86 | |
| | | 105.76 |
| Gain in section | | 45.57 |
| **Eleventh section:** | | |
| Inflow—River below Bohman Ditch | | 95.86 |
| Outflow—River at United States Geological Survey gauging station | | 107.86 |
| Gain in section | | 12.00 |
| **Twelfth section:** | | |
| Inflow—River at United States Geological Survey gauging station | | 107.86 |
| Outflow— | | |
| Davis and Weber Counties Canal | 33.67 | |
| Bambrough Ditch | 3.28 | |
| Dunn Ditch | 3.93 | |
| Uinta Central Ditch | 19.59 | |
| Pioneer Ditch | 4.49 | |
| Jones Ditch | 3.62 | |
| South Weber Ditch | 7.22 | |
| Riverdale Ditch | 18.68 | |
| Weber Ditch | 10.76 | |
| Taylor Mill Race (estimated) | 1.00 | |
| Wilson Canal | 4.08 | |
| Hooper Canal | 8.45 | |
| River below Hooper Canal | .00 | |
| | | 118.77 |
| Gain in section | | 10.91 |

Only two sections show losses. The loss in the first section may be accounted for in part by the fact that the seepage from irrigation in this section is returned to the river below the point selected as the end of the section. The fourth section also shows a small loss. It is possible that even in this section a gain might have been shown, as a ditch on the left bank of the river, which was reported dry and for that reason was not visited, might have been drawing a little water. Gains will be noticed in all other sections of the river. As suggested earlier in this report, these measurements can not be taken as accurately stating the gains, yet enough is shown to prove that the gains from seepage on Weber River are very great. If we may take the figures of the tables as approximately true the aggregate through that portion of the valley which is irrigated will amount to more than 250 per cent of the water found in the river at the mouth of the upper canyon. This large gain from seepage helps to mitigate the evils of unrestrained diversions from the river. Although the upper ditches take all the water at their heads, it does not entirely deprive those lower down.

## MEASUREMENTS ON EAST CANYON CREEK.

In 1898 a record was kept of the flow of East Canyon Creek during the months of September, October, and November. These measurements were made by means of weirs placed in the creek by W. N. Bostaph, civil engineer, of Ogden. The mean flow during these months at the point where the dam of the East Canyon Reservoir was constructed was 10.64 cubic feet per second. During the same months at a point near the mouth of the creek 14 miles below the dam it was 10.76 cubic feet per second, showing a slight increase.

On August 31, 1899, from measurements made by Mr. Bostaph there was found 64.91 cubic feet per second at a point 2 miles below the dam. On September 1 Mr. Bostaph found 64.80 cubic feet per second flowing in the creek at a point near its mouth 14 miles below the dam. This shows a slight decrease. The report from which these measurements were taken does not state whether any water was taken from the creek by ditches between the two points.

June 28, 29, and 30, 1900, the following series of measurements was made along the creek by Mr. Bostaph: At a point 2 miles below the dam the flow was 53.64 cubic feet of water per second. Three miles below the dam, Sheep Creek discharged 0.65 cubic foot of water per second into East Canyon Creek. At the creamery, 12 miles below the dam, 31.56 cubic feet per second was found in the creek. Between this point and the upper point of measurement four ditches take 36.86 cubic feet per second from the creek, hence the gain to this point is 14.13 cubic feet per second. Near the mouth of the creek, 14 miles below the dam, a measurement showed 51.29 cubic feet per second in the creek, showing a gain in the lower 2 miles of 19.73 cubic feet per second, and a gain between the two extreme measurements of 33.86 cubic feet per second.

On July 13, 1900, the writer assisted Mr. Bostaph in making a series of measurements along East Canyon Creek. At this time 46.84 cubic feet per second was found at the point 2 miles below the dam. Two ditches were found to be taking 16.19 cubic feet per second from the creek below this point and above the point where the next measurement of the creek was made. The creek was measured at a point 9 miles below the dam, and 33.52 cubic feet per second was found, which shows a gain of 2.87 cubic feet per second. At the creamery, 12 miles below the dam, 22.83 cubic feet per second was found in the creek. This shows a loss in this section, 3 miles in length, of 10.69 cubic feet per second, since there was no water taken from the creek in this section. At the point near the mouth of the creek 47.92 cubic feet per second was found in the creek, showing a gain in the last 2 miles of 25.09 cubic feet per second.

On August 16, 1900, another series of measurements was made by Mr. Bostaph, assisted by the writer. The upper measurement was made at a point 4 miles below the dam, and below the head of a small ditch belonging to Fred White, which was carrying 0.58 cubic foot per second. Giving the creek credit for this amount, there was found at this point 36.74 cubic feet per second. Three ditches between this point and the point where the creek was measured, 9 miles below the dam, take from the creek 8.57 cubic feet per second; 33.64 cubic feet per second was found in the

creek at this point, which shows a gain in this section of 5.47 cubic feet per second. At the creamery 24.33 cubic feet per second was found in the creek; 1.62 cubic feet per second was taken out in this section. The loss shown in this section is 7.69 cubic feet. Thirty-eight and nineteen one-hundredths cubic feet per second was found in the creek near its mouth, which shows a gain of 13.86 cubic feet per second. The gain between the extreme measurements was 11.64 cubic feet per second.

A fourth series of measurements was made on East Canyon Creek August 30 and 31, 1900, by the writer, assisted by Mr. D. D. Dibble. At a point 4 miles below the dam, and below the head of Fred White's Ditch, there was 9.27 cubic feet per second flowing in the creek. Seventy-five one-hundredths of a cubic foot per second was found in White's Ditch, which, added to the flow of the creek, makes 10.02 cubic feet per second at this point. At the point 9 miles below the dam there was 3.87 cubic feet per second found in the creek. In this section of 5 miles the waters of the creek were increased by 1.38 cubic feet per second from Hardscrabble Creek, and three ditches take out 10.38 cubic feet per second, making 2.85 cubic feet per second gain. At the creamery no water was flowing in the creek. Eighty-six one-hundredths of a cubic foot per second was taken out in this section. This makes a loss of 3.01 cubic feet per second. Fourteen and fifty-eight one-hundredths cubic feet per second was found in the creek at its mouth, which was gained in the lower 2 miles. The gain between the extreme measurements was 14.42 cubic feet per second. Other measurements have been made on this creek, but they were not complete enough to be included in this report.

A comparison of all the measurements brings out the following facts: Neither gain nor loss is great up to the seventh mile below the dam, two of the measurements indicating a loss and two indicating a gain up to this point. Between the seventh and the ninth miles all of the measurements show a gain, that of June 28 and 30 showing a very decided gain in this section. For the section between the ninth and twelfth miles a loss is shown in all the series except that of June 28 and 30, and the gain in this is very small. In the lowest section all the measurements show a decided gain; the gains being so marked in this section would seem to indicate that they were not entirely due to the water that disappears from the higher sections of East Canyon Creek. To determine with accuracy the source of this gain a more extended study of the question would be necessary.

## THE CONSERVATION OF THE PRESENT WATER SUPPLY.

There are a number of ways in which the present water supply may be increased or made to do a greater duty in crop production.

The first and most important is the impounding of the flood waters of spring and early summer in storage reservoirs.

Second. The water supply may be increased by draining the lands along the river that have become water-logged from the effects of irrigation above them.

Third. Greater economy in transportation of water from the stream to the lands to be irrigated should be practiced.

## EAST CANYON CREEK RESERVOIR.

The only reservoir of any importance that up to this time has been constructed in the Weber Valley is that on East Canyon Creek, constructed and owned by the Davis and Weber Counties Canal Company. The dam is built across East Canyon Creek, at a point known as the Narrows, in Morgan County. The width of the canyon at this point is 54 feet at the bed of the creek, and bed rock was reached at a depth of 35 feet. The foundation—which is of concrete composed of one part Portland cement, two and one-half parts sand, and five parts of broken stone—is 15 feet in thickness and extends across the canyon and from bed rock to the bed of the creek.

The dam, as completed in the spring of 1899, has a height of 68 feet above the bed of the creek and a top length of 120 feet. The core of the dam is a vertical steel plate, riveted and calked, set firmly in the concrete foundation. Its ends were let into the side walls 1½ feet, and united with them by filling the grooves with asphaltum concrete. The faces of the steel plate were also coated with asphaltum concrete 4 inches in thickness. The lower 20 feet of this steel plate is three-eighths of an inch thick; the next strip, 20 feet wide, is five-sixteenths of an inch thick; the remaining 28 feet is one-fourth of an inch thick. Stability is secured by dry rubble masonry, having a width of 10 feet on top, a slope of 1 to 2 on the downstream face, and 1½ to 1 on the upstream face. The outlet of the reservoir is through a tunnel in solid rock at the north end of the dam. This tunnel is 5 by 6 feet in cross section, and some 180 feet in length. The bottom of the tunnel is 58 feet below the top of the dam. The principal valves are placed in this tunnel about two-thirds of its length from the upper end. There are two valves, each placed between two lengths of cast-iron pipes 30 inches in diameter and 12 feet in length. The two lines of pipe in which the valves are set are placed side by side, and the tunnel around the pipes is stopped with concrete. The valves are operated by hand wheels placed on the ends of shafts which are carried up to the top of the valve chamber. Two auxiliary valves similar to the main valves are set at the upper end of the tunnel. The pipes in which these valves are set are imbedded in cement concrete similar to the pipes carrying the main valves. By the use of these upper valves the water may be shut out of the tunnel, permitting repairs to be made in the tunnel or main valve, if necessary.

After the irrigating season of 1900 the company decided to enlarge the capacity of the reservoir by the addition of 25 feet to the height of the dam. The plan for this additional height is similar to the plan of the original dam, with the exception that the steel plate instead of being vertical is inclined 30° downstream. In order to give the plate additional strength, heavy T bars running up and down are riveted to it at intervals of 10 feet. These bars are of two lengths, alternating with each other. One set extends from the bottom up for a distance of 14 feet; the other set extends from bottom to top. The plate is backed by a layer of cement concrete 1 foot thick, which is supported by dry rubble masonry 20 feet thick on top. This is supported by loose rock, having a slope of 1 to 2 downstream. A timber waste way, supported on masonry laid in concrete mortar, is located at the south end of the dam. It is 30 feet wide and 6 feet deep, with a fall of 1 foot in 8. It will return the water to the creek below the toe of the dam. The length of the completed dam on top is 173 feet, and its height is 83 feet above the bottom of the tunnel.

The area of the reservoir at the height of the original dam was 226 acres. The capacity was 167,000,000 cubic feet, or 3,834 acre-feet. The area of the reservoir at the height of the present dam is 262 acres. The capacity at this area is 370,691,400 cubic feet, or 8,510 acre-feet. The cost of the original work was $50,000, and the cost of the addition will reach the same sum, making the total cost of the reservoir $100,000. The site selected for this reservoir is an ideal one. At the point where the dam is located the rock walls of the canyon are 54 feet apart at the level of the creek bed and 173 feet apart at the top of the present dam, which is 93 feet above the the level of the creek bed. The canyon below the dam narrows in to about 40 feet. With these conditions it seems entirely practicable to increase the height of this dam much beyond the present limit, still retaining a large factor of safety. Economy would suggest the use of high dams if such use could be accompanied by perfect safety. The cost of the original dam per acre-foot of storage capacity was $13.05, but as at present constructed the cost per acre-foot is $11.75.

Owing to the rapid falling off in the discharge of the Weber River the Davis and Weber Counties Canal Company was entitled to none of the natural flow of the river after the last week in June, 1900, and the reservoir gates were accordingly opened June 23, 1900. The supply stored was drawn off in forty-eight days, at an average rate of about 40 cubic feet per second.

The water is discharged into East Canyon Creek and flows through East Canyon Creek and Weber River, a distance of about 30 miles, to the head gate of the canal. The separation of the reservoir water from the natural flow of the Weber River was during the season of 1900 a source of much contention. The settlement of the question as to what deduction shall be made for losses in transit involves the determination of the gain or loss from seepage and other sources in the stream from the reservoir to the head gate of the canal where it is taken from the river. A large number of measurements have been made at intervals along East Canyon Creek with this object in view, and also one series on Weber River. These measurements were made before the construction of the dam, as well as afterwards. The measurements on both East Canyon Creek and Weber River show an increase in flow from source to mouth, even when all visible inflow is taken into account, so that no conclusion as to what percentage of the reservoir water is lost in transit can be based on these measurements. There is undoubtedly a loss, but it can not be ascertained in this way. The measurements are given in the discussion of seepage.

## DRAINAGE ALONG THE STREAMS.

In the irrigation development of any community the lands first to be watered are those lying contiguous to the streams, as this involves the minimum expenditure of labor and money. As settlement spreads lands farther from streams are brought under irrigation. The water applied to these lands sinks into the soil and the lower lands lying nearer the stream in time may become so saturated as to be totally unfit for cultivation, and the lowest of them may become sloughs filled with stagnant water. This effect may be seen in many places along the valley of Weber River. The drainage of these lands will produce a double benefit—the water may again be applied to a beneficial use, and the lands drained again be made capable of producing crops. Under present conditions some of this water finds its way back

to the river, but only after the lands become saturated and the lower places are converted into stagnant pools.

The water which thus might be developed along the Weber River in many localities would, without doubt, have a value for irrigation far in excess of the cost of draining these areas. The expense of the drainage should be divided between the owners of the land reclaimed and those wishing to use the water, for the benefits derived will be mutual.

### GREATER ECONOMY IN CONDUCTING WATER FROM THE STREAMS.

In some instances, noticeably in Chalk Creek Valley, and also in the lower valley of the Weber, on both sides of the river near Uinta, irrigating waters are carried in a number of small ditches paralleling each other to a great extent, and cutting the farms needlessly. Economy would suggest that where the lay of the ground permits one large ditch should be used to carry the water rather than several small ones. Experience has shown that the relative loss of water from seepage and evaporation is less when carried in large streams than when the same amount of water is carried by a number of smaller ones. A further advantage of such combinations is that decreasing the number of ditches across a cultivated area increases the area available for crop production.

### THE CROPS OF WEBER VALLEY.

From the officers of the various ditch companies throughout the valley the writer obtained a list of the names and addresses of all persons who irrigated land under the various ditches in the valley. In most instances it was also possible to obtain from the ditch officers the number of acres irrigated by each person. Nineteen hundred and sixteen names were thus obtained, and to each one of these persons was sent a letter of inquiry regarding acreage and value of crops grown. The number of replies returned was not as large as was expected, being only about 24 per cent of the inquiries sent out. These were carefully tabulated, and the results are considered of sufficient importance to justify their publication. The average values of the various crops obtained from the answers received have been carefully calculated with a view of finding the average value of the crop produced by an acre of irrigated land in the Weber Valley.

The total number of acres irrigated in Summit County, compiled from all sources of information, is 13,490¼. Fifty per cent of this number of acres was reported in the replies received. The balance of the acreage was obtained from the statements of the ditch officers, and can not be greatly in error. The total value of the crops grown was obtained by multiplying the total number of acres under each ditch by the average value of 1 acre of crop obtained for that particular ditch from the replies received. Of the area in Morgan County, 7,156¾ acres, 37 per cent was reported in response to the circulars. Of the area in Davis and Weber counties under the lower ditches, 18,284½ acres, 31 per cent was reported in the replies.

The following tables give the total number of acres irrigated in each county, the value per acre, and the total value of all crops raised, computed as above described:

*Area and value of crop in Summit County.*

| Name of canal. | Area. | Value per acre. | Total value. |
|---|---|---|---|
| | *Acres.* | | |
| Private ditches on Upper Weber | 1,360.00 | $8.21 | $11,165.60 |
| New Field and North Bench | 1,400.00 | 8.30 | 11,620.00 |
| Marion Ditch | 1,291.00 | 10.21 | 13,181.11 |
| Gibbons Ditch | 200.00 | 8.26 | 1,652.00 |
| Boulderville Ditch | 889.00 | 7.00 | 6,223.00 |
| South Bench Ditch | 787.00 | 10.45 | 8,224.65 |
| Private ditches above Peas | 280.00 | 8.00 | 2,240.00 |
| Spring Creek Ditch | 95.75 | 8.70 | 833.02 |
| Left bank Fort Creek Ditch | 29.00 | 20.37 | 590.73 |
| Right bank Fort Creek Ditch | 297.00 | 15.43 | 4,582.71 |
| Rockport Ditch | 263.75 | 9.49 | 2,502.99 |
| Private ditches below Rockport | 94.50 | 11.78 | 1,113.21 |
| Pine Creek Ditch | 195.00 | 11.57 | 2,256.15 |
| Private ditches above Wanship | 126.50 | 14.26 | 1,819.07 |
| East Wanship Ditch No. 1 | 415.00 | 11.89 | 4,934.35 |
| Turner Ditch | 5.00 | 3.00 | 15.00 |
| Wanship Ditch No. 2 | 192.50 | 11.66 | 2,283.05 |
| Hoytsville Ditch No. 1 | 407.00 | 19.30 | 7,855.10 |
| Private ditches near Hoytsville | 425.00 | 15.35 | 6,523.75 |
| West Hoytsville Ditch | 270.00 | 16.01 | 4,322.70 |
| Peck Creek Ditch | 143.00 | 8.56 | 1,266.88 |
| Elkhorn Ditch | 159.00 | 19.35 | 3,076.65 |
| Coalville and Hoytsville Ditch | 270.00 | 15.88 | 4,287.60 |
| Bodebach Ditch | 115.00 | 13.71 | 1,576.65 |
| Ditches on Upper Chalk Creek | 399.00 | 12.24 | 4,883.76 |
| Huff Creek Ditch | 115.00 | 14.53 | 1,670.95 |
| Ditch from south bank Chalk Creek | 85.00 | 14.25 | 1,211.25 |
| North Narrows Ditch | 191.00 | 13.93 | 2,660.63 |
| Upper Robinson Ditch | 142.00 | 12.67 | 1,799.14 |
| Lower Robinson Ditch | 12.50 | 8.96 | 112.00 |
| City Cemetery and Chalk Creek Ditch | 227.75 | 13.44 | 3,060.96 |
| Middle Chalk Creek Ditch | 112.50 | 13.39 | 1,506.38 |
| Extension Middle Chalk Creek Ditch | 94.00 | 21.60 | 2,030.40 |
| North Chalk Creek Ditch | 256.00 | 15.95 | 4,083.20 |
| Calderwood Ditch | 78.00 | 10.75 | 838.50 |
| Grass Creek Ditch | 60.25 | 12.55 | 756.13 |
| Private ditches on Echo Creek | 806.00 | 6.33 | 5,114.64 |
| John Shill Ditch | 89.00 | 9.50 | 870.50 |
| Franklin Canyon | 116.00 | 10.00 | 1,160.00 |
| Hogsback Canyon | 10.00 | 6.00 | 60.00 |
| Henefer Ditch | 1,029.75 | 12.68 | 13,057.23 |
| Total | 13,490.75 | 10.98 | 148,821.64 |

*Area and value of crop in Morgan County.*

| Name of canal. | Area. | Value per acre. | Total value. |
|---|---|---|---|
| | *Acres.* | | |
| Croydon Ditch | 424.00 | $14.83 | $6,287.92 |
| Private ditches on Lost Creek | 515.00 | 9.74 | 5,016.10 |
| North Round Valley Ditch | 246.00 | 17.51 | 4,342.46 |
| South Round Valley Ditch | 250.00 | 13.94 | 3,485.00 |
| Private ditches in East Canyon | 15.25 | 51.45 | 784.61 |
| East Porterville Ditch | 320.00 | 31.72 | 10,150.40 |
| West Porterville Ditch | 592.00 | 15.15 | 8,968.80 |
| Old Fort Ditch | 1.50 | 44.00 | 66.00 |
| East Richville Ditch | 282.00 | 14.80 | 4,231.60 |
| Richville Mill Race Ditch | 511.00 | 14.62 | 6,671.72 |
| Welch Ditch | 139.00 | 5.86 | 817.23 |
| Littleton and Milton Ditch | 685.00 | 13.92 | 9,535.20 |
| North Morgan Ditch | 432.00 | 16.21 | 7,002.72 |
| Private ditches near Morgan | 185.50 | 12.86 | 2,385.53 |
| Steward and Stoddard Ditch | 75.00 | 17.05 | 1,278.75 |
| South Morgan Ditch | 302.00 | 16.96 | 5,121.92 |
| Morgan City Ditch | 382.00 | 17.83 | 6,273.46 |
| Enterprise Ditch | 340.00 | 9.64 | 3,277.60 |
| North Milton Ditch | 451.00 | 12.66 | 5,709.66 |
| Deep Creek Ditch | 362.00 | 14.06 | 5,089.72 |
| River Ditch | 136.00 | 12.84 | 1,745.24 |
| Peterson Creek Ditch | 62.00 | 10.43 | 646.78 |
| Cottonwood Creek Ditch | 275.00 | 7.78 | 2,139.50 |
| Garden Creek Ditch | 81.50 | 25.05 | 2,041.58 |
| Total | 7,156.75 | 14.70 | 105,265.50 |

*Area and value of crop in Davis and Weber counties.*

| Name of canal. | Area. | Value per acre. | Total value. |
|---|---|---|---|
| | *Acres.* | | |
| Davis and Weber Counties Canal | 4,000.00 | $22.00 | $88,000.00 |
| Bambrough Ditch | 282.00 | 10.42 | 2,938.44 |
| Dunn Ditch | 261.00 | 21.82 | 5,695.02 |
| Uintah Central Ditch | 234.00 | 24.26 | 5,676.84 |
| Pioneer Ditch | 120.00 | 24.80 | 2,976.00 |
| Jones Ditch | 100.00 | 37.15 | 3,715.00 |
| South Weber Ditch | 960.00 | 36.22 | 22,795.00 |
| Riverdale Ditch | 1,041.25 | 37.83 | 39,075.11 |
| Weber Ditch | 235.00 | 37.90 | 8,906.50 |
| Old Wilson Ditch | 304.75 | 71.47 | 21,780.48 |
| Wilson Canal | 3,676.50 | 28.71 | 86,236.32 |
| Hooper Canal | 6,080.00 | 18.35 | 147,360.80 |
| Total | 18,294.50 | 22.06 | 436,184.21 |

*Total area and value of crops in Weber Valley.*

| | | |
|---|---|---|
| Area | acres.. | 38,932.00 |
| Value per acre | | $17.69 |
| Total value of crops | | $688,844.74 |

It will be noticed that the average value of 1 acre of crop varies through quite wide limits. Thus, in Summit County, the minimum value reported is $3 under the

Turner Ditch. The maximum value reported is $21.60 under the extension of Middle Chalk Creek Ditch. In Morgan County the minimum value reported is $5.88 under the Welch Ditch. The private ditches under East Canyon Creek report a value of $51.45, which is the maximum in that county. Under the ditches in the lower valley the minimum value is $10.42, reported under the Bambrough Ditch, while $71.47, reported under the Old Wilson Ditch, is the maximum. Owing to incomplete reports, these values may not exactly represent the average values of all crops raised, but for the ditches named they are practically correct. The total number of acres for the entire valley, 38,932, is probably too small, but the writer has no data for estimating the error. For these reasons, it is thought that the value, $688,844.74, given as the total value of crops raised by means of irrigation from the waters of the Weber River, is well within the truth, and if the accurate value could be determined, it would be greater than the sum given.

The table given below shows the comparative value per acre of the principal crops grown in the three counties:

*Value per acre of different crops.*

| Name of crop. | Counties. | | |
|---|---|---|---|
| | Summit. | Morgan. | Davis and Weber. |
| Alfalfa | $11.56 | $11.26 | $18.14 |
| Wheat | 10.78 | 12.96 | 14.32 |
| Oats | 14.45 | 14.02 | 13.09 |
| Barley | 16.27 | 12.05 | 11.72 |
| Potatoes | 32.05 | 45.52 | 51.29 |
| Corn | 15.67 | 16.00 | 15.56 |
| Orchard | 58.92 | 41.89 | 47.62 |
| Garden | 36.10 | 33.08 | 47.44 |
| Tame hay | 11.20 | 13.89 | 5.67 |
| Wild hay | 7.52 | 6.62 | ..... |
| Tomatoes | ..... | ..... | 65.85 |
| Sugar beets | ..... | ..... | 38.06 |

Alfalfa seems to give greater returns in the lower valleys, which may be due somewhat to better prices. The value of the crop in Summit and Morgan counties is shown to be very nearly the same by these reports. Wheat values per acre increase in going down the river, while oats and barley seem to give better values in the higher valleys. The value of potatoes increased in going down the valley. The value of the corn crop shows very little difference in the different portions of the valley. The value of the orchard crop in Summit County is evidently too great, and may be explained by the fact that the values of only 2½ acres were reported from Summit County. In all probability this report is much more favorable than would be warranted by actual conditions. The area being so limited the error introduced in the totals would be insignificant. Garden values are higher in the lower valley, as a greater variety of vegetables can be grown and the seasons are longer. The reports show greater value for the hay crop, except in the case of hay from alfalfa, which has already been noted in the upper and intermediate valleys. In the classification, tame hay and wild hay, which is here used, tame hay includes timothy, clover, and redtop,

whether grown separately or mixed. Wild hay includes the hay from natural or native meadows usually located along the streams. The low value given for tame hay in Davis and Weber counties may possibly be accounted for, as 27 acres only were reported and all under one ditch. This estimate is probably too low for timothy hay in the lower valley, but the small area reported would not affect the total to any great extent.

Two quite important crops grown in the lower valley are tomatoes and sugar beets. The area devoted to these crops is quite large, which partly accounts for the higher average value given for an acre of crop in the lower valley.

The importance of these two crops in this part of Utah is evidenced by nine canning factories, and a beet-sugar factory. Reports from five of the canning factories give in the aggregate $115,775.50 as the amount paid to farmers for fruits and vegetables canned during the season of 1900. Three of these factories report nothing but tomatoes. One company handles 1,750 tons of tomatoes; another, 877 tons, and the third, 2,500 tons of tomatoes. The report of the operations of one company which put up both fruits and vegetables during the season of 1900 is as follows:

*Money paid out for produce, 1900.*

| | | |
|---|---|---|
| 1,129 | tons tomatoes, at $10 | $11,290.00 |
| 160 | tons peas, at $25 | 4,000.00 |
| 113 | tons peaches, at $25–$30 | 3,107.50 |
| 45 | tons apricots, at $25–$30 | 1,237.50 |
| 67 | tons plums, at $15–$20 | 1,172.50 |
| 10 | tons prunes, at $15–$20 | 175.00 |
| 5 | tons asparagus, at $40 | 200.00 |
| 7 | tons pie cherries, at $50 | 350.00 |
| 27 | tons pumpkins, at $4 | 108.00 |
| 300 | tons apples, at $20–$25 | 6,750.00 |
| 33 | tons string beans, at $30 | 990.00 |
| 5 | tons raspberries, at $100 | 500.00 |
| 3 | tons strawberries, at $100 | 300.00 |
| 6½ | tons gooseberries, at $50 | 325.00 |
| | Total | 30,505.50 |

These figures represent prices received by the farmers and fruit growers. The orchard company paid $34,200 for the fruit and tomatoes that they handled during the season of 1900.

The beet-sugar factory at Ogden handled 28,000 tons of beets during the season of 1900, for which the company paid $4.25 per ton, or $119,000, to the growers.

## DUTY OF WATER.

In the work which was done in Utah on the Weber River during the season of 1900 no attempt was made to determine the duty of water by carefully measuring the quantity of water that was used on a certain area of crop. Notwithstanding this fact, the writer can not refrain from calling attention to a condition which the observations seem to reveal. Most irrigators concede that a crop may be injured by too much water as well as by too little. The table following shows a comparison of the values of the crops as estimated by the owners in the lower valley of the Weber, and

the depth of water applied during the last half of July and all of August. While this comparison shows nothing conclusive, it does show that the ditches which applied the most water during this period are not the ones that report the greatest value for 1 acre of crop.

*Value of crop and depth of water used during last half of July and August, 1900.*

| Name of canal. | Total area reported. | Value of crop per acre reported. | Depth of water applied. |
|---|---|---|---|
| | *Per cent.* | | *Feet.* |
| Bambrough | 11 | $10.42 | 0.94 |
| Dunn | 41 | 21.82 | .82 |
| Uinta Central | 29 | 24.26 | 5.59 |
| Pioneer | 18 | 24.80 | 3.09 |
| Jones | 20 | 37.18 | 2.86 |
| | 100 | 36.23 | 1.06 |
| South Weber | 14 | 37.53 | 1.33 |
| Riverdale | 8 | 71.47 | ..... |
| Old Wilson | 19 | 28.71 | ..... |
| Wilson | 22 | 18.35 | .11 |
| Hooper | | | |

The Bambrough, Dunn, Old Wilson, Wilson, and Hooper canals, during the period covered by these observations, put on less than a foot in depth of water, and estimates of values vary from $10.42 per acre to $71.47 per acre. The latter estimate is probably greatly in excess of the value for the whole canal, as only a small area under this ditch was reported.

The Jones, South Weber, and Riverdale ditches applied during this period from about 1 foot in depth to nearly 3. Estimated values under these ditches vary from $36.23 to $37.53 per acre. The Pioneer and the Uinta Central ditches covered the ground during this period to a depth varying between 4 feet and over 5½ feet, and the values per acre are estimated at $24.80 and $24.26, respectively.

## ESTIMATED VALUE OF WATER STORED IN EAST CANYON CREEK RESERVOIR.

A circular letter was sent last fall by the secretary of the Davis and Weber Counties Canal Company to all the holders of the ditch and reservoir stock, asking each to state the value of the crops produced above that which would have been produced without the reservoir water. From the answers returned the officers of the company have made a careful estimate that the value of this water was $60,000 during the season of 1900. This estimate places a value of $15.65 per acre-foot for this reservoir water. Sixty thousand dollars return upon an investment of $50,000 gives a rate of interest of 120 per cent. From this it will be seen that in the two years of use the reservoir has paid for itself nearly two and one-half times.

If this estimate of $15.65 per acre-foot be taken as the average value of the reservoir water, the value of the water impounded in 1901 will be $133,000. This return upon an investment of $100,000 gives a rate of interest of 133 per cent, and the value of the storage reservoir as an aid to irrigation appears to have been conclusively demonstrated. Neither the Weber nor its tributaries were examined for available reservoir sites. The writer, however, heard of a number, but had not

the time to visit them. The large flood flow of the river in early summer and the high value of water in the latter part of the season would seem to justify the construction of reservoirs if proper sites are available.

## SUMMARY.

### DISCHARGE OF WEBER RIVER.

The annual discharge of the Weber River is ample to irrigate all the lands that can be reached with its waters. June is the last month of each season in which the natural flow of the stream is sufficient to supply all of the ditches with water. The quantity which passes Devils Gate during the months of May and June of each year if fully utilized would cover 60,000 acres of land to a depth of 5 feet. This would permit the present irrigated area under the Weber and its tributaries to be increased 50 per cent.

### WATER RIGHTS AND CLAIMS.

Records are kept at the county seats. The earlier records which were made under the law of 1880 were supposed to grant a primary or secondary right, as the case might be, to the waters of the Weber for irrigation or other useful purposes. Later the law under which these records were made was held to be void. Under this decision these rights are not secured to the claimants as supposed, but the records have a value as testimony which may be used in securing the rights which are claimed.

The claims as recorded are indefinite, as no definite quantity of water is claimed, and in the majority of cases the area is indefinite.

### WATER-RIGHT DECREES.

The courts having jurisdiction over water rights in the Weber Valley have rendered decrees granting definite quantities of water to three ditches only—the Riverdale, the Wilson, and the Hooper—granting 18.67, 90, and 115.01 cubic feet per second, respectively, or a total of 223.68 cubic feet per second.

A decree has been rendered by the court adjudicating the claims of the irrigators on Lost Creek. The judgment rendered is based upon the proportionate flow of the stream, and is in force only during the low-water season of each year. A commissioner is appointed by the court to execute the judgment.

The State should provide some inexpensive and efficient means for adjudicating the water claims. Water has been used for irrigation in Utah for nearly half a century, and to adjudicate these claims fairly is a task of no little difficulty, and time is only increasing these difficulties. The adjudication should be made for the entire watershed at one time, and not for each county, or even a smaller section, alone.

### DISTRIBUTION OF WATER FROM THE RIVER.

In the past the natural flow of the Weber was large enough to satisfy all of the demands that were made upon it, and each individual irrigator could take what he desired without doing an injury to another. In these circumstances no officer was required to divide the water among the various claimants. During a period of

shortage of water this system is not at all satisfactory, as those ditches so situated on the stream as to be able to get the water will take it with little regard for the rights of others who may have rights equally good. Some ditches draw from 60 to 121 per cent of the amount claimed, while others less favorably located get only 3.4 to 12.2 per cent of amount decreed by court.

### DIVISION OF WATER UNDER DITCHES.

Under many of the ditches the division of water during periods of shortage is made according to a time schedule, giving to each irrigator the entire flow of the ditch for a certain definite time for each share owned in the ditch, which scheme permits some claimants to use six times as much water per acre as others. The use of weirs placed at right angles to each other, as in the division of water under the Davis and Weber Counties Canal, one at right angles to the current the other parallel with the stream, will not divide the water into parts proportional to the lengths of the weirs unless the velocity of approach is entirely eliminated, which is not done under the above-named canal and the division as made at present is not an accurate one.

### STATE CONTROL.

The State should not only distribute water among the various claimants, but should also fix by statute the minimum area which may be irrigated by one cubic foot of water per second.

### SEEPAGE MEASUREMENTS.

From the observations reported, the gains along the Weber River from this source are very great, amounting to more than 150 cubic feet per second in the length of the river from the mouth of the upper canyon to the head gate of the Hooper Canal at Ogden, or about 250 per cent of the amount found in the river at the upper point.

The observations on East Canyon Creek show large gains from seepage for a distance of 12 to 14 miles, during the times when the East Canyon Reservoir was being emptied, varying between 32 and 63 per cent of the water found in the creek at the upper point of measurement. When the creek was carrying simply the natural flow the gain was 144 per cent. The last measurement was made fifteen days after the reservoir had been emptied. This would indicate that the gains in the lower section of the creek were not entirely due to the water sinking higher up in East Canyon Creek.

### THE CONSERVATION OF THE PRESENT WATER SUPPLY.

The early floods of the Weber River would permit the storage of water for use later in the season. In the case of the Davis and Weber Counties Reservoir in East Canyon, 3,884 acre-feet of water were impounded in 1900 at a cost of $13.05 per acre-foot. In 1901, 8,510 acre-feet were impounded at a cost of $11.75 per acre-foot.

The water-logged areas of land along the stream should be drained so as to permit the use of this water for irrigation on the lands below and also to reclaim these lands and again render them productive.

Where practicable water should be transported in one large channel rather than a number of small ones.

### THE CROPS OF WEBER VALLEY.

From information from all sources it was estimated that there were 13,490.75 acres irrigated in Summit County in 1900 from the waters of the Weber River and its tributaries and that the average value of the crops grown was $10.93 per acre. In Morgan County the irrigated area was estimated at 7,156.75 acres and $14.70 was the mean value of one acre of crop. In Davis and Weber counties it is estimated that the irrigated area is 18,284.50 acres and the average value of an acre of crop is $23.86. The total area is 38,932 acres and average value of the crop grown on an acre is $17.69, making a total value of the crop in the Weber Valley $688,844.74.

### THE VALUE PER ACRE OF THE DIFFERENT CROPS.

Average values reported from Summit County are from $7.52 for wild hay to $53.92 for orchard. In Morgan County the average values are from $6.62 for wild hay to $45.52 for potatoes. In Davis and Weber counties the values are from $5.67 for tame hay to $65.85 for tomatoes.

There are nine canning factories handling fruits and vegetables in the lower Weber Valley. Five canning factories report a total of $115,775.50 paid to farmers for fruit and vegetables canned during the season of 1900. The different kinds of fruit and vegetables handled by these factories are tomatoes, peas, peaches, pears, apricots, plums, prunes, asparagus, cherries, pumpkins, apples, string beans, raspberries, strawberries, and gooseberries. The beet-sugar factory at Ogden reports that 28,000 tons of sugar beets were handled by them during the season of 1900, for which the growers received $4.25 per ton, or a total of $119,000.

### DUTY OF WATER.

The conclusions reached as to the duty of water may be taken as approximations only, since no careful experiments were undertaken and the observations which were made were begun about the middle of July, when a large part of the irrigation had been done. The reports of reduced crops under those canals which used the largest volumes of water the latter part of the season would seem to warrant the conclusion in those cases that too much water was used.

### VALUE OF STORED WATER.

The season of 1900 was an unusually dry one. The water used by the Davis and Weber Counties Canal after June 23 was drawn from the East Canyon Reservoir, which is owned by this company. From careful estimates made by the officers of the company the value of the crops produced above the value which would have been produced if the water in the reservoir had not been available was $60,000. On this basis the 3,834 acre-feet which were stored had a value of $15.65 per acre-foot. The cost of this reservoir is $50,000, and the return on this investment during the season of 1900 was 120 per cent.

The large floods of spring and early summer and the scarcity of water during the latter part of the season suggest the construction of reservoirs to utilize the water that usually goes to waste during the floods.

# AGRICULTURE UNDER IRRIGATION IN THE BASIN OF VIRGIN RIVER.

By FRANK ADAMS, *Irrigation Assistant.*

## THE BASIN OF VIRGIN RIVER.

South of the Great Basin and north of the Colorado River, comprising portions of southwestern Utah, northwestern Arizona, and southeastern Nevada, is an agricultural district perhaps as little known as any in the great Southwest. It is the region irrigated from Virgin River. (Map, Pl. XIV.)

Including the areas drained by all of the tributaries, the basin of Virgin River comprises a region of between nine and ten thousand square miles. Except during the summer cloudbursts the rainfall of much of this area never reaches the river; from some of it, as the upper Meadow Valley Wash, extending northward from the source of Muddy Creek, in Nevada, it never does. Consequently, the area included in the investigation with which this report will deal is considerably less than ten thousand square miles—not over six or seven thousand. This smaller area extends in irregular outline from the headwaters of the Virgin River in the 7,000-foot plateau of northern Kane County, Utah, southerly to its union with the Colorado in southeastern Nevada, approximately 200 miles. It is a typical mountain desert country, with its characteristic stretches of sand and sage brush, its cloudless sky and scorching sun. Much of the area, but that in Utah especially, was the center of volcanic eruptions and tremendous geologic displacements, until what is now the valley of Virgin River became in some sections a succession of faults and folds of intense scientific interest. Through these the stream and its feeders have slowly cut their way in winding courses, leaving the narrow valleys and flood plains which now support the thirty towns and villages of the region.

The upper waters of Virgin River are in two branches, Zion Creek and East Fork or Long Valley Creek, the two joining a short distance above the settlement of Rockville, Utah. These flow for many miles through narrow canyons, below which they widen out enough in places to leave a few acres of tillable land. Below the confluence of Zion Creek and East Fork the valley of the river becomes more open. To the south is Hurricane Ledge, 5,000 and 6,000 feet high, stretching away nearly 100 miles to the Grand Canyon of the Colorado, and forming one of the steps from the lower to the upper areas of the Colorado Basin. On the north, Colob Plateau, 8,000 and 9,000 feet high, forms the watershed from whose snows are fed the spring and summer flows of the Virgin River. West of Colob Plateau is a broken district in which North and La Verkin creeks have their sources, and flow southward to the river. Still to the west the Pine Valley Mountains rise to an elevation of 9,000 feet, to feed Ash Creek on the east and north and Santa Clara Creek on the west and south. Both are tributaries of Virgin River, the former entering it 4 miles below

Toquerville and the latter 2 miles south of St. George. Southwest of St. George are the Virgin Mountains, 5,000 and 6,000 feet high; west are the Beaverdam Mountains, of about equal elevation. Through the gap between the two ranges, 20 miles southwest of St. George, the Virgin River has cut a canyon which separates this valley and that of the lower river in Arizona and Nevada. Below the canyon the watershed on the south is a continuation of the Virgin Range; on the north the river drains the southern slope of the Mormon Range. Both ranges reach elevations of 9,000 and 10,000 feet.

## THE AGRICULTURAL SECTIONS OF THE BASIN.

The irrigable sections of Virgin River Basin are scattered throughout the length of the river and its tributaries, from an elevation of about 1,300 feet at the mouth of the river to one of 6,750 feet on the headwaters. They are either entirely along the stream bottoms or on the contiguous bench lands. The area already devoted to farms is but a small percentage of that which could be farmed were water available for its irrigation. Varying in elevation and exposure, they furnish a diversity of seasons and temperature, and consequently permit the growth of a wide range of products, from the apple and the potato in the higher, colder districts, to cotton and sorghum in the lower valleys. In these lower valleys, particularly in southern Nevada, the climate is such that this range of products could in all probability be widened to include some of the subtropical fruits that thrive in California and southern Arizona. The unwatered irrigable areas are in general of the same character and present the same physical conditions as the watered areas. Of the unwatered areas the bench lands predominate. On the upper reaches of the stream no lands but these remain open, for there the narrow bottoms have been tilled almost since the first settlement in the basin.

## CLIMATE.

The rainfall of the valley of Virgin River ranges from 3 to 4 inches at St. Thomas, Nev., 25 miles above the mouth of the river, to 10 inches or slightly more, in parts of Washington and Kane counties, Utah. The most complete records available have been kept by the United States Weather Bureau at St. George, Utah. These records show that for a period of nine years, from 1893 to 1901, the mean annual precipitation was 6.31 inches, and the mean annual temperature 57.6 degrees. The year of greatest rainfall was 1897, when 9.81 inches fell; and of lowest rainfall 1894, when only 3.55 inches fell. During this period the months of least mean precipitation were, in order, June, September, November, and May, and the greatest mean precipitation August, February, January, and March. The lowest monthly mean was 0.1 inch, in June, and the highest, 1.11 inches in August. There has been no year in the nine in which at least one month was not devoid of precipitation. In five months in 1901, four months in 1894, three months in 1898, two months in 1893, 1895, 1897, 1899, and 1901, the total precipitation was not over 0.01 inch; in some of these months there was no precipitation. The greatest fall for one month during the period was 2.98 inches, in July, 1896. The months of lowest mean temperature during these years were, in order, December, January, February, and November,

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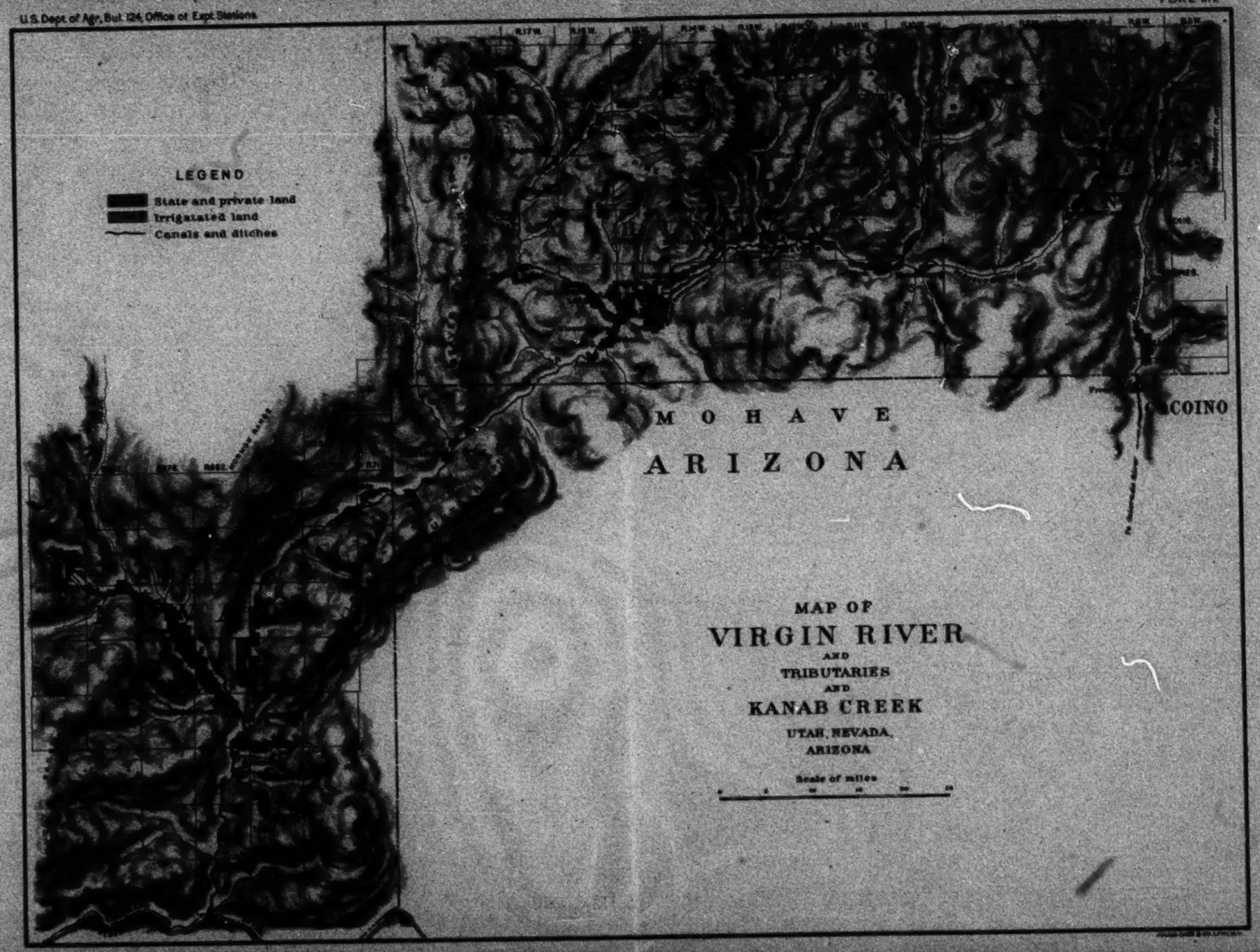


MAP OF

# VIRGIN RIVER

AND

TRIBUTARIES

AND

# KANAB CREEK

UTAH, NEVADA,
ARIZONA

Scale of miles

0 5 10 15 20 25

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and of the highest mean temperature, July, August, June, and September. The lowest monthly mean was 36°, in December, and the highest 81.1°, in July. The lowest recorded temperature for the period was 1°, on January 2, 1901, and the highest 115°, on July 29, 1898. For the four years 1898 to 1901, 79 per cent of all the days were clear, 12 per cent were partly cloudy, 9 per cent were cloudy, and only 9 per cent rainy.

From these data it is plain that in the valley of Virgin River the rainfall is light all of the year, but lightest the last of spring and the beginning of summer and in the fall; that the temperature is devoid of low extremes but reaches high extremes in summer; and that most of the days are clear. It is therefore a region well adapted to agriculture by irrigation.

## VIRGIN RIVER.

Virgin River is a stream of uncertain flow and shifting bed. In winter and early spring it is fed chiefly by the springs at its source, but in summer the principal supply is from the melting snows and heavy rains in the higher watershed. While there is always water in the river in its upper reaches, it is often dry in the lower end. The flow is torrential, the floods following either a heavy downpour of short duration or warm rains on the snow-covered plateaus of the watershed. The heavy downpours occur usually in July and August, and sometimes cause much damage to the farming lands along the river bottoms. Especially during the floods, but also in all but the seasons of very low water, the river carries in suspension a large percentage of sediment, which not only fills the head gates and ditches along its course, but also makes the impounding of water in the channel of the river impracticable. The river bed is of shifting sand, offering a foundation for none but temporary dams. This sandy bed widens at the lower end of the river to several hundred yards, over which the river spreads in a thin, sluggish sheet, causing a heavy loss of water through seepage and evaporation. During the summer the river is not a continuous stream. No water passes from Long Valley, on East Fork, to the stream below, and the bed is dry in the canyon below St. George. In the lower canyon springs again feed the river, but 40 miles below it once more becomes dry in the early summer—by May 15 in 1902—remaining so, except during a week or ten days after floods, until the cool weather begins in the fall. A number of gaugings of the river were made during the spring and summer of 1902, and a daily record of the depth was kept from March 20 to October 15 at the sulphur springs between La Verkin and Hurricane benches. At that point the river is confined in a rocky channel, but of not entirely even sides. The shifting sand in the bottom prevented using a fixed gauge rod, so that depths were measured daily. The table of daily discharge at this point is given in connection with a discussion of water titles on pages 231, 232.

The measured discharges of the river at various points are given in the following table:

*Gaugings of Virgin River, 1902.*

| Date of gauging. | Place of gauging. | Discharge. |
|---|---|---|
| 1902. | | Cu. ft. per sec. |
| March 7 | 500 feet above St. George and Washington Field Dam | 143.78 |
| March 20 | Sulphur Springs, La Verkin Bench | 104.05 |
| March 31 | Junction of Zion Creek and East Fork (streams ganged separately, Zion Creek having a flow of 45.84 cubic feet per second, and East Fork having a flow of 42.93 cubic feet per second). | 88.77 |
| April 8 | Sulphur Springs, La Verkin Bench | 89.51 |
| April 28 | 400 yards below lower narrows and 3 miles above Littlefield | 111.02 |
| May 19 | Sulphur Springs, La Verkin Bench | 79.71 |
| June 1 | On north and south line in center of sec. 32, T. 42 S., R. 15 W | 8.12 |
| June 20 | Sulphur Springs, La Verkin Bench | 31.69 |
| June 21 | Below Virgin City Fields | 35.18 |
| June 21 | One-fourth mile above head of Upper Farming Land Ditch, Virgin City | 42.04 |
| June 23 | do | 51.18 |
| June 23 | Above Rockville South Ditch | 49.71 |
| July 2 | East Fork, 300 yards above Glendale Dam | 7.39 |

## THE SETTLEMENT OF VIRGIN RIVER BASIN.[a]

The spirit of colonization so pronounced with the leaders of the Mormon faith, coupled with a determination to make their new empire self-supporting, led them to push their borders 300 miles to the south within ten years after they first entered Salt Lake Valley. Freighters from Salt Lake to southern California in 1847 had returned with stories of an unused river to the south, passing through green valleys and surrounded by wide expanses of fertile desert land. They told also of the Indians who awaited the uplifting touch of civilization—possible converts to the new faith. Two years later Parley Pratt, one of the leaders, explored the district under commission from the provisional State of Deseret. In 1854 missionaries were sent out, under Jacob Hamblin, to prepare the way for later settlers. Hamblin spent several months among the Indians along the Santa Clara, and gave them their first lessons in irrigation. In the fall of 1854 Hamblin and his associates set to work on a dam across Santa Clara Creek, a few miles above the present town of Santa Clara.

During the next few years increased attention was given to the southern field. In 1856 the first settlement of Santa Clara, about one-half mile above the present Santa Clara, was established by a few farmers. In 1857 Washington was settled, and the first water for irrigation taken from Virgin River. The land watered at that time was from 75 to 100 acres on the right bank of the river. In 1858 an experimental cotton farm was started at Heberville, now Price, a few miles below St. George, and cotton raised at a cost of $3.40 per pound. In 1859 the farm was continued and the cost price reduced to $1.90 per pound, when the settlement was

[a] The data relating to the history and settlement of the Virgin Basin were obtained principally from the records of the court of Washington County, from Mr. James G. Blake, clerk and historian of the Mormon Church at St. George, and from conversations and interviews with pioneer settlers.

temporarily abandoned. The same year a few acres was watered by William Hamblin about one-half mile below the present town of Gunlock. Prior to the settlement of Washington, in 1857, a military post, for protection against the Indians, had been established on the east side of Ash Creek, northwest from what is now known as Kelseys, and called Fort Harmony. There a small stream of water was diverted for irrigation. Later the fort was moved across Ash Creek and known as Old Fort Harmony. A larger field was watered there until the winter of 1861–62, when the settlement was washed away and present Harmony established, and the irrigated acreage still further increased. Next after Harmony, Toquerville was founded, followed by Virgin City, with five or six families. After Virgin City came the old Grafton, which was later washed away and superseded by the present Grafton. After these settlements, and prior to 1861, came in order Rockville, first known as Adventure, Shunesburg, Northup, just above Rockville, and Springdale.

With the breaking out of the civil war in the spring of 1861, the Mormon leaders foresaw a possible cutting off of the American cotton supply, and hence a renewed cause for making their people self-supporting. Accordingly, this year saw redoubled efforts to utilize the waters of the Virgin and its tributaries. Three hundred families started from Salt Lake to this river in the fall of 1861. In November a body of 50 or 60 Swiss people founded Santa Clara on its present site. In December the majority of the 300 families pitched their tents a short distance from where St. George now is, moving in a body to the present site a month later. At the same time the upper river settlements of Toquerville, Virgin City, Grafton, Rockville, Springdale, and Shunesburg were strengthened. Soon after the arrival of these colonists a severe flood undid much of the work of the earlier settlers. The pioneer dam built by Hamblin and the Indians on the Santa Clara was torn out and the settlements of Gunlock, Old Fort Harmony, and Grafton, as well as much of the bottom land along the Virgin River, washed away. The former narrow and somewhat regular channels of both the Virgin and the Santa Clara rivers were torn and widened. In the opinion of many of the old settlers who witnessed the flood, the flow of both streams, as well as of some of the other tributaries, was permanently increased by the opening of springs theretofore closed.

Notwithstanding this discouraging beginning, a ditch leading from Virgin River was commenced before the settlers had been located a month, and was carrying water 6 miles by the end of 1862. It had a width of 6 feet and a depth of 3 feet and passed through a timbered tunnel 900 feet long. The work of construction was necessarily so hurried that some of it was not lasting. In the first four years and eight months after St. George was founded $26,611.59 was spent in repairing and replacing dams and sections of the ditch, which had thus far watered 420 acres, making a tax of over $63 per acre for water alone. In 1864 the water tax per acre was $10.88; in 1865, $12; in 1866, $9, and in 1867, $9. But for the fact that these taxes were largely paid in labor it would have been impossible for the settlers to meet them. To reduce the burden somewhat, 50 wild-grass lots along the Virgin River, directly south of St. George, were sold at auction, netting $4,306, and this sum placed in the fund for completing and enlarging the tunnel. Nor did these severe conditions give way to better conditions at once. For a number of years after 1867 the annual water tax in the Virgin Field, to which the first ditch led, was $13 per

acre. It was found practically impossible to build a dam in the river that would withstand even the more moderate floods. Rocks and piles sank in the quicksand of the river until hope of building a permanent dam was almost given up. On January 12, 1876, fourteen years after the little band pitched their tents in Virgin Valley, the official returns made to the board of directors of the Virgin Field showed that there were then 34 miles of community canals and ditches on the Virgin River and Santa Clara Creek, which had cost $55,993; that there were 74 miles of private ditches, which had cost $5,820; that the cost of repairing dams and ditches had been $18,150, and that the total cost for irrigation works had been $79,963. In 1877 another attempt at dam building in the river was made about 1¼ miles above the tunnel, at a cost of over $4,000 for the dam and canal leading to it. In 1881 the sum of $3,584 was collected for repairs from 448 acres, a tax of $8 per acre. In 1882 the amount fell to $1,088.62 for the Virgin, Jarvis, and Seep Ditch fields.

These figures but partially tell of the burden that had to be borne in settling the new southern wilderness. The cost of living was excessively high. Common labor cost $3 per day. Flour cost from $15 to $25 per hundred pounds. The price of sugar was $1 per pound; of molasses, $4 per gallon; of common cotton domestic, $1 per yard; of coal oil, $8 per gallon. One hundred dollars a thousand feet was paid for lumber 50 and 75 miles away. A sheep for a pound of tea was a common bargain. Provisions of all kinds were freighted by mule teams from San Bernardino or Los Angeles, Cal., at 16 cents a pound. Traffic in these commodities was practically all by barter, for cash was seldom if ever in circulation. Nor was there other than a local basis for values. Prices of produce to pay for work on dams and ditches were determined in mass meetings of the owners of the land watered. Prices of produce for taxes were fixed by the county court, and it is not uncommon to find entries in the county court records such as that made December 7, 1863, which states that "it was decided that molasses, at $1.75 per gallon, be paid R. L. Lloyd for 72 pounds of cotton, which is hereby appropriated to pay for the probate and county court seals."

The type of institution in the Virgin Valley is essentially cooperative, as it is elsewhere among the Mormons. If the rights of one settlement to water are encroached upon by the farmers elsewhere, the natural method is to stand firm as a local unit until the wrong is righted. If new lands must be brought under ditch to keep the young men at home on the farms, the usual procedure is a joining of forces until the result is accomplished. If water for irrigation is to be distributed, the only way the settlers know is to work together until each man has his rightful share. Thus it is that a forbidding country has been made fruitful where individual effort would have failed.

The early history of these pioneers has been given in some detail because it is the first step in understanding the agricultural conditions of the valley. Without it one can not appreciate the character of farming on Virgin River nor the care with which the necessary improvements in irrigation must be made. The farmer of the Virgin River is the farmer of small means and modest wants. Yet his 5 acres of alfalfa is his fortune. Losing it he loses everything but an opportunity to make a new start in a different country where life is strange to him.

Settlement of both the upper and lower valleys of the river did not follow for several years after the founding of St. George and surrounding towns. About 1866

there was a movement to the valley of Muddy Creek, which is the lower tributary of the Virgin, joining it from the north in southern Nevada, 25 miles above the junction of the Virgin with the Colorado. This movement, known as the Muddy Mission, resulted in the settlement of the towns of St. Thomas, near the end of Muddy Valley, Overton, and St. Joseph, near the upper end of the valley. Ditches were built and irrigation carried on for several years, but through dissatisfaction of the settlers, caused by uncertainty as to whether the valley was part of Nevada or part of Utah, the valley was abandoned early in 1871, and the settlements founded left to ruins. It was not for a number of years that the once cultivated fields received further attention, but they now again support the three towns. The name of St. Joseph has been changed to Logan.

The settlement of the Upper Virgin Valley, known as Long Valley, followed in about 1870. Mount Carmel, lowest in the valley, and Glendale, a few miles above, were organized as precincts June 27, 1871. Orderville, between the two, was started about the same time.

## EXTENT AND CONDITIONS OF IRRIGATION IN THE BASIN.

The farms on Virgin River, as elsewhere in Utah, are in community groups surrounding or not far from the settlements from which they are worked. Only in rare instances does a farmer live on his farm, but instead, in the village made up of his neighbor farmers. This compact village type considerably alters agricultural methods and makes the farms less diversified than is common in intensely cultivated farm homes. There is no place in the field for the fruit and vegetables that ordinarily supply so much of the farmer's living. Those products are grown in the village dooryards, where they can have the requisite care and attention. His field is essentially a one-crop field, generally alfalfa, or it may have also wheat or oats. He hauls his product 1, 2, or 4 miles to town, where he stacks it for the winter's feeding.

Agriculturally considered, the Virgin River is naturally in three divisions—that of which St. George is the center and which will be designated in this report as the central division, extending from the narrows above Rockville to the canyon below St. George; that reaching from Littlefield and Beaverdam to the mouth of the river, the lower division; and that of Long Valley, at the head of East Fork, which will be called the upper division. As already shown, these divisions are separated by natural barriers, and, in the distribution of the water of the river, no account is taken in any of the three divisions of the use of water in the other two. This is because in the dry seasons water does not pass down the river from Long Valley to the central division, nor from the central division to the lower division. In discussing the subjects of this report the three divisions will, therefore, be considered separately.

### THE CENTRAL DIVISION OF THE BASIN.

The central division of Virgin Basin is the furthest developed and the most important of the three. The largest settlement is at St. George, the county seat of Washington County and the chief city of southern Utah. Next in magnitude are the settlements at La Verkin and Hurricane benches, which are both new. Besides these three, the central division includes Bloomington, Price, and Atkinville, on the Virgin

River below St. George; the valley of Santa Clara Creek, including Santa Clara, the Shebits Indian farm, Gunlock, Magotsa, Pine Valley, and Grass Valley; Washington and Middleton, just above St. George; Harrisburg and Leeds, on Quail Creek; Harmony, Kanarraville, Bellevue, and Toquerville, on Ash and Kanarra creeks; Virgin City, on the river at the mouth of North Creek; Mountain Dell and The Mill, on North Creek; Grafton, Rockville, and Springdale, on the river at the mouth of Zion Creek.

### ST. GEORGE.

The agricultural lands farmed from St. George are mainly in five fields—the St. George and Washington Field, 4 miles southeast of town; the Jarvis Field, 2 miles south of town; the field under the Santa Clara Seep Ditch, directly west of the Jarvis Field; and the two St. George Clara fields, on the Santa Clara Creek bottoms, about 2 miles southwest of St. George. The land in these fields is in individual holdings. Except at Atkinville, the water used in their irrigation is distributed by incorporated companies of which the landholders are the shareholders. Title to the water is supposedly vested in the companies and stock in these companies entitles its holders to shares of the water furnished.

### ST. GEORGE AND WASHINGTON FIELD.

The largest field is the St. George and Washington Field, which embraces something over 2,000 acres. It is located on a low-lying bench south of the Virgin River and is watered through the St. George and Washington Field Canal, the largest canal now in operation in the basin. The canal heads 10 miles above St. George and follows the south bank of the river for 5 miles, when it turns to the south to reach the field. Its total length is 10 miles, its width an average of 9½ feet, and its depth an average of 3 feet. Just prior to leaving the bank of the river it passes around Shnaubkibe Mountain, where heavy construction work was necessary. About 1 mile below this it divides, one branch turning west to that part of the field called the old field, the larger branch continuing to the main or new field.

The construction and maintenance of this canal and the dam diverting water into it have been a heavy burden on the farmers. The dam and the canal have cost to date for construction and repairs nearly $70,000. Building the dam has been particularly costly and difficult. Experiment after experiment demonstrated the construction of a permanent dam across the sand bottom of the Virgin River to be practically impossible. What was expected to be a successful effort was made some years ago 4 miles below the present dam. At a large expense heavy piles were sunk into the river bed to hold the rock and brush work of the dam, but they proved unable to withstand the summer floods, with the result that when water was most needed and plentiful in the river there was no dam to divert it to the fields. With the washing away of the dam the farmers became satisfied that unless a solid foundation could be found the fields would have to be abandoned. They accordingly sought a new site, which they found where the present dam is located. At that point the river had swung to the left of a stratum of rock which protruded above the river bed. For a number of years some of the farmers held the idea that by damming the channel of the river so as to throw the river to the right over this

stratum, diversion works could be made that would stand. By so doing, full play would be left for the floods, while the dry dam across the original channel would turn the water into the head of the canal. This plan was carried out, and thus far it has proved a success.

The plan of the dam is shown in fig. 1. It is 600 feet long from the spillway to the left bank of the stream, 25 feet high, and 15 feet wide on top, with a slope on the upper face of 2½ to 1 and on the lower face of 2 to 1. Within is a rock core 12 feet wide on the bottom and 4 feet wide on top. At the end of the dam toward the rock stratum is an abutment facing the end of the dam, the ends curving slightly from the stream so as to throw the stream from the dam and over the rock stratum to the right. This abutment is of rock, is 50 feet long, 12 feet high, and 12 feet wide at the upper end and 6 feet wide at the lower end. From the abutment the rock stratum extends 235 feet to what is now the right bank of the river channel. At the abutment this stratum is 90 feet wide, from which it increases to 200 feet at the opposite bank. Through the stratum a short distance toward the center of the stream from the abutment a spillway 6 feet wide and 6 feet deep has been cut in

FIG. 1.—Plan of St. George and Washington Dam.

the solid rock, in which is placed a sheet-iron gate 5½ feet wide and 7 feet high to the windlass. To the left of the abutment is the head gate of the canal, which follows the rock dam to the original left bank of the river, where it turns to a higher stratum. By means of the iron gate in the spillway the flow through the head gate into the canal is regulated. Directly above the tunnel through the stratum on the left bank is a second more substantial head gate. The dam has raised the bed of the river 10 feet.

According to careful estimates made on October 1, 1895, by a committee appointed by the county commissioners of Washington County, the area of irrigated and irrigable land under the St. George and Washington Field Canal is 3,510 acres. July 1, 1902, the books of the field company showed a total of 2,175 acres to be drawing water. This was on a basis of 1 acre to each water share, which is the usual basis of figuring. The holdings that were receiving water varied from 1 to 75 acres, averaging a little over 17 acres.

As already stated, the water used for the irrigation of this field is controlled by an incorporated company, the St. George and Washington Canal Company. It was incorporated July 10, 1900. Prior to that date the company was known as the

Washington Field Canal Company, which was incorporated May 11, 1875, and which had at its organization acquired the interests of its shareholders in a dam across Virgin River, and several miles of ditches, valued in all at $12,500. The St. George and Washington Canal Company was organized with a capital stock of $50,000, divided into 4,000 shares. The property of the Washington Field Canal Company which was transferred to the new company consisted of the dam and spillway across Virgin River, valued at $12,000; 10 miles of main canal, valued at $16,000; lateral, waste, and rain ditches, and division gates, valued at $4,000, and other property valued at $1,800, making a total of $33,800.

The water carried in the canal is distributed to the shareholders of the company in proportion to the number of shares held. When it reaches the field it is divided into several streams, their size depending upon the amount of water in the canal, and these streams are given to the different shareholders for periods of time corresponding to their shares, usually one or two hours per share for each watering.

A difficult problem that the St. George and Washington Company, as well as all other irrigators from Virgin River, has to meet is getting rid of the sand deposited in the canal. So large is the amount of this sand that without some way of disposing of it the canals would often be filled with it in a few hours. The method followed is frequent sluicing. Gates for this purpose are placed at intervals of a few hundred yards, near the head of the canal, and at greater distances farther down. The bottoms of the gates are 2 or 3 feet below the bottom of the canal, thereby so increasing the force of the currents through the gates as to cut out the deposited sand for some distance both above and below the gates. It is found necessary to sluice the St. George and Washington Canal at least one hour each day and a longer time on Sundays. Besides the periodical sluicing, when the canal carries sufficient water to permit, small streams are constantly passing through the upper gates, carrying with them much of the sand that has already been precipitated by the arrested current in the canal. As at present managed, the sluicing causes considerable waste of water in the dry season. To have water for sluicing it is necessary to take into a canal more water than is delivered to the field. When the canal is emptied each day and for a longer time on Sunday, allowing the full flow of the canal to pass down the river, the gates of lower canals are not arranged to take advantage of the increased supply and the water which might be utilized is allowed to evaporate or sink in the dry bed of the lower narrows. The extent of this loss is shown in Pl. XV, figs. 1 and 2. Fig. 1 is from a photograph of Virgin River about 2 miles below Atkinville, taken on May 25, 1902. At this point the river was nearly 200 feet wide, but only a few inches deep. Fig. 2 is from a photograph of the river less than 3 miles below, taken the same day. No diversions were made between the two points, yet the entire flow was lost. Such losses are common throughout the basin of the river.

Irrigation in the St. George and Washington Field is accomplished by flooding, and by carrying the water through shallow furrows about 2 feet apart made with a wooden marker. This is the method common in southern Utah. It is the practice to cover the fields once in from ten to fifteen days during the irrigation season, which extends from March to October. Water is applied at irregular intervals, both before and after these dates, some usually reaching the field in every month of the

FIG. 1.—VIRGIN RIVER 2 MILES BELOW ATKINVILLE, MAY 25, 1902.

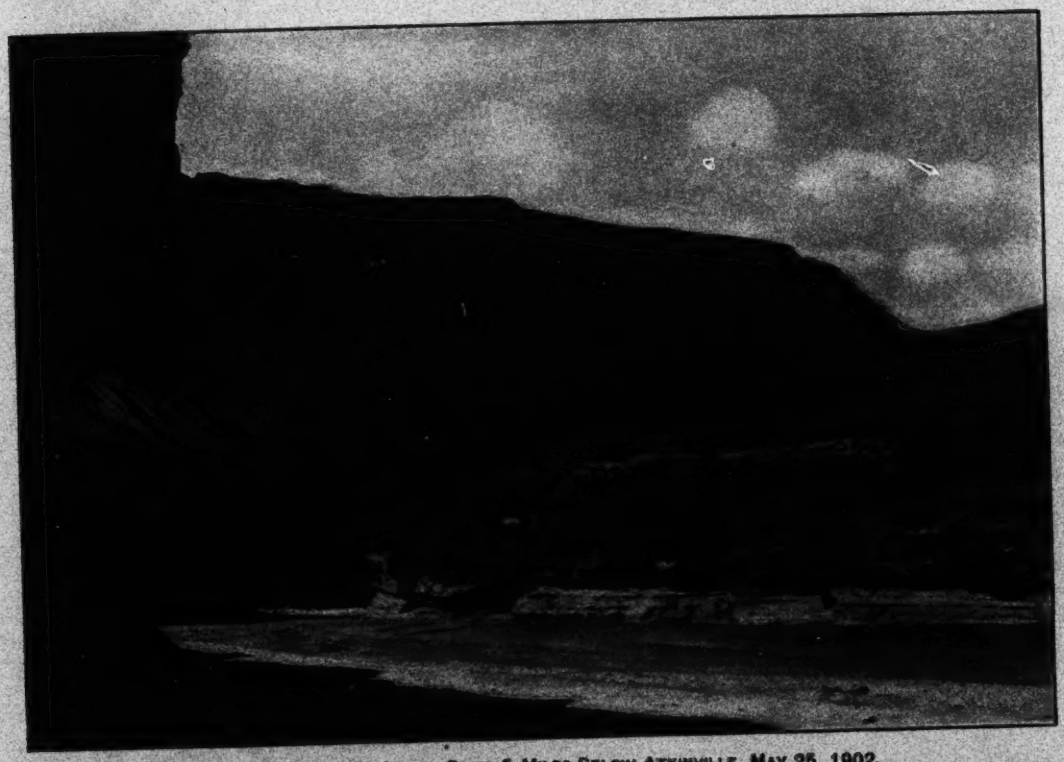

FIG. 2.—DRY BED OF VIRGIN RIVER 5 MILES BELOW ATKINVILLE, MAY 25, 1902.

year. The annual assessment for ditch maintenance averages about 75 cents per acre.

The amount of water used on crops in the St. George and Washington Field has been a subject of much discussion, but prior to 1902 no measurements were made to determine this. Through the aid of Mr. Henry Schlappy, ditch rider, a daily record of the flow of the canal has been kept during the season of 1902. The following table, which gives the daily flow, shows considerable fluctuation from day to day:

*Flow of water in St. George and Washington Field Canal during irrigation season of 1902.*

| Day. | April. | May. | June. | July. | August. | September. | October. |
|---|---|---|---|---|---|---|---|
| | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* |
| 1 | ..... | ..... | 78.65 | 92.86 | 59.51 | 22.72 | 86.78 |
| 2 | ..... | 85.12 | 83.13 | 40.66 | 41.16 | 65.47 | 92.05 |
| 3 | ..... | 102.15 | 80.55 | 62.47 | 31.06 | 59.51 | 109.10 |
| 4 | ..... | 102.60 | 75.70 | 64.46 | 43.97 | 82.56 | 72.20 |
| 5 | ..... | 95.96 | 75.05 | 66.45 | 52.87 | 62.11 | 77.90 |
| 6 | ..... | 29.21 | 76.46 | 61.49 | 47.61 | 68.43 | 88.71 |
| 7 | ..... | 81.36 | 69.83 | 60.50 | 45.62 | 66.50 | 81.86 |
| 8 | ..... | 100.15 | 73.76 | 59.51 | 46.58 | 70.42 | 68.43 |
| 9 | ..... | 92.15 | 74.10 | 12.40 | 102.15 | 55.80 | 66.50 |
| 10 | ..... | 104.95 | 63.65 | ..... | 98.02 | 52.75 | 70.42 |
| 11 | ..... | 97.85 | 62.11 | 44.28 | 64.09 | 57.00 | 57.40 |
| 12 | ..... | 83.85 | 95.02 | 43.14 | 86.78 | 56.23 | 95.05 |
| 13 | ..... | 84.90 | 62.11 | 39.67 | 56.34 | 65.03 | 94.21 |
| 14 | ..... | 95.21 | 58.23 | 41.16 | 41.74 | 72.30 | 66.43 |
| 15 | ..... | 87.64 | 58.43 | 43.14 | ..... | 86.78 | 70.42 |
| 16 | ..... | 75.50 | 51.24 | 43.14 | ..... | 69.55 | ..... |
| 17 | 100.15 | 84.48 | 63.47 | 59.51 | ..... | 107.10 | ..... |
| 18 | 96.21 | 95.96 | 65.03 | 77.39 | 26.28 | 100.70 | ..... |
| 19 | 100.15 | 96.07 | 58.28 | 89.26 | 77.86 | 29.42 | ..... |
| 20 | 99.17 | 104.95 | 52.56 | 102.15 | 74.10 | ..... | ..... |
| 21 | 102.15 | 95.96 | 52.56 | 19.15 | 91.24 | ..... | ..... |
| 22 | 99.17 | 48.25 | 53.38 | ..... | 75.70 | 42.72 | ..... |
| 23 | ..... | 72.02 | 53.08 | 34.30 | 91.24 | 98.21 | ..... |
| 24 | ..... | 96.21 | 45.60 | 42.15 | 77.64 | 84.30 | ..... |
| 25 | 98.76 | 18.18 | 45.62 | 43.14 | 68.43 | 77.86 | ..... |
| 26 | 96.21 | 44.62 | 37.69 | 54.26 | 74.10 | 66.43 | ..... |
| 27 | 80.55 | 77.30 | ..... | 85.12 | 59.51 | 71.75 | ..... |
| 28 | 91.82 | 77.86 | ..... | 107.10 | 94.05 | 66.94 | ..... |
| 29 | 93.23 | 29.59 | 35.96 | 105.15 | 94.22 | 82.22 | ..... |
| 30 | 98.02 | 86.78 | 63.47 | 80.55 | 91.24 | 80.75 | ..... |
| 31 | ..... | 80.75 | ..... | 59.51 | 15.20 | ..... | ..... |
| Total | 1,155.59 | 2,429.27 | 1,744.01 | 1,996.72 | 1,827.51 | 1,901.94 | 1,236.96 |

The canal carried some water both before the record was begun and after it was discontinued, but, as shown by the table, it delivered to the field between March 21 and October 15, 11,979 acre-feet, or sufficient to cover the land watered to a depth of 7.22 feet. From October 15 to November 28, 1,991 acre-feet of water was used, making the total amount applied during the season 13,970 acre-feet, which gives a depth over the 1,660 acres watered of 8.41 feet, and, with the rainfall added, of 8.98 feet.

Through the aid of Mr. James McArthur, water master for the St. George and Washington Field, complete crop return data were gathered for the purpose of showing the money value of the water carried by the canal. A total of 1,660 acres was watered, planted to crops as follows: Alfalfa, 1,342.5 acres; wheat, 194.5 acres; corn, 40.5 acres; oats, 19 acres; sorghum, 17.5 acres; barley, 11.5 acres; fruits, vegetables, etc., 34.5 acres. Alfalfa received an average of 6.9 waterings between April 8 and October 6, and yielded an average of 3.40 tons per acre. Wheat received an average of 3.3 waterings between April 17 and June 25, and yielded an average of 27.46 bushels per acre. Oats received an average of 3.7 waterings between April 20 and June 17, and yielded an average of 35.78 bushels per acre. Barley received an average of 3.2 waterings between April 17 and June 25, and yielded an average of 27.46 bushels per acre. After the alfalfa crop was harvested the meadow furnished pasturage valued at $3,131. The total return from the 1,660 acres was $37,113, or an average per acre of $22.36. The return per acre-foot of water artificially applied was $3.10.

### JARVIS FIELD.

The Jarvis Field lies on the right bank of Virgin River, 2 miles southeast of St. George, and is the next field below the St. George and Washington Field. The Jarvis Ditch leaves the river on the right bank through a cut in a rock ledge, has a width of 5 feet, and when full, carries water to a depth of 1.5 feet. May 13, 1902, 30 feet below the lowest sand gate and about 100 feet below the dam, it was carrying 14.84 cubic feet per second, which approximates the usual high-water flow. During 1902 about 200 acres were being irrigated from the ditch.

The Jarvis Ditch was started in 1865, and for the first few years watered between 200 and 300 acres. At one time, about 1874, 500 acres were watered. On June 15, 1880, the Jarvis, Cooper, Bottom, Seep, and Virgin ditches, the latter then known as the Rio Virgin North Canal, were united in the Rio Virgin Canal Company on the theory that the Rio Virgin North Canal, if properly managed, could, in dry seasons, be made to better cover the land formerly covered by the three ditches. This arrangement continued for three years, during which time it was demonstrated that the Rio Virgin North Canal could not cover the three fields. Thereupon the Jarvis and Seep ditches again became separate, and the Rio Virgin North Canal was abandoned.

The annual assessment for care and maintenance of the Jarvis dam and ditch is from $1.50 to $2 per acre.

### SANTA CLARA SEEP DITCH.

The Santa Clara Seep Ditch diverts the water that passes the upper dams in Santa Clara Creek or returns to the creek in seepage from the fields above. It heads in Santa Clara Creek near the lower end of the St. George Clara fields, and waters 214 acres on the lower Santa Clara bottoms north of Virgin River and west of the Jarvis Field. This ditch is controlled by the Santa Clara Seep Ditch Company, which was incorporated January 6, 1896, with a capital stock of 244 shares of water right, of the par value of $25 each. The 214 acres watered is owned by 20 irrigators, whose average holdings are 10.7 acres. Each acre receives water from one and one-half to two hours each watering, the waterings occurring every fifteen or

sixteen days. The annual assessment for care and maintenance of the Seep Ditch is from 75 cents to $1 per acre, of which one-fourth is paid in cash and three-fourths in labor. As the water carried by the ditch is limited it is seldom sold apart from the land.

THE ST. GEORGE CLARA FIELDS.

The two St. George Clara fields, excepting the land under the Santa Clara Seep Ditch, are the two lowest fields receiving water from Santa Clara Creek. They cover land on both sides of Santa Clara Creek below the Santa Clara fields and settlement, and above the Santa Clara Seep Ditch. There is supposedly 800 acres in the two fields, embracing 67 holdings, averaging a little less than 12 acres each. The control of the water for irrigation is held by the St. George Clara Field Company, which was incorporated August 22, 1901, with a capital stock of 800 shares, of the par value of $10 each. The fields are watered by the Upper and Lower St. George Clara ditches, heading a short distance apart, directly above the town of Santa Clara. Each acre draws water for from one to three hours each watering, depending on the supply in the creek, the water being distributed by one water master.

For the purpose of ascertaining the approximate duty of water on the Santa Clara bottoms, a record of the flow in the two canals was kept during the season of 1902. There are no flumes in either ditch, so that it was necessary to make the ratings in earth sections. The streams were small at times and hence difficult to measure, but the record is thought to be of value. The record was commenced with the beginning of regular irrigation on March 17, and ended October 15. Owing to the failure of the supply in Santa Clara Creek, neither ditch carried water after June 24. The irrigation season, which ordinarily lasts until fall, was therefore over with the beginning of summer. There was not sufficient water in the creek to fill both ditches even up to June 25, making it necessary to alternate the supply between the two. From March 24 to June 10, as measured at the head, Upper Ditch carried 643.93 acre-feet, and from March 17 to June 24, Lower Ditch carried 684.31 acre-feet, making a total for the two fields of 1,328.24 acre-feet.[a] Although there are 800 acres in the field supposedly watered, the area actually watered was only 485 acres. Spread over this area the 1,328.24 acre-feet covered the land to a depth of 2.74 feet. The rainfall for the season was 0.57 foot, so that the total depth of water received by the land was 3.31 feet.

Careful and complete crop returns were gathered with the help of Erastus B. Snow, of St. George. The principal products grown were alfalfa, 272 acres; wheat, 170 acres; and barley, 35 acres. Alfalfa was irrigated between January 15 and July 26,[b] received

[a] The discharge of each ditch by months was as follows:

| Month. | Upper Ditch. | Lower Ditch. |
|---|---|---|
| | *Acre-feet.* | *Acre-feet.* |
| March | 104.02 | 94.41 |
| April | 375.98 | 195.36 |
| May | 109.49 | 343.35 |
| June | 54.54 | 51.19 |
| Total | 643.93 | 684.31 |

[b] A few farmers had a little water after June 24.

an average of 2.2 waterings, and yielded an average of 3.62 tons per acre. Wheat was irrigated between January 15 and June 24, received an average of 2.5 waterings, and yielded an average of 22.38 bushels per acre. Barley was irrigated between February 15 and May 20, received an average of 2.5 waterings, and yielded an average of 27.64 bushels per acre. Besides the marketable products, the land produced pasturage worth $429. The total value of crops and pasturage was $10,279, making the average return per acre $21.20. In figuring the returns alfalfa was reckoned at $6 per ton, wheat at 90 cents per bushel, and barley at 75 cents per bushel. For the 1,328.24 acre-feet of water applied in irrigation, the value per acre-foot was therefore $7.73.

The above figures represent the returns from farming the Santa Clara bottoms in a dry year. All irrigators reported a shortage of water, so that it is safe to assume that the returns would be considerably more in years of ample water supply.

### LA VERKIN BENCH.

La Verkin Bench is directly north of Virgin River and 3 miles southeast of Toquerville. It comprises a tract of 700 acres of irrigable land, of which 538 acres are under La Verkin Canal, and 150 acres within reach of pumping above the canal. La Verkin Canal takes water from Virgin River 2 miles above the bench, and after following the canyon of the river 1¼ miles, tunnels through the cliffs east of the bench 840 feet to La Verkin fields. The canal and tunnel were completed in 1891 at a cost of $25,500. The canal was originally 5 feet wide on the bottom, 7 feet wide on top, and 2 feet deep, with a fall of 1 inch in 10 rods, except at the upper end, where a slightly greater fall was given. Owing to financial difficulties it was found impossible to keep the canal in repair for several years after it was completed, and consequently its capacity is at present somewhat below what it was at first. The head gate has twice washed out and an assessment of $500 had to be collected in 1902 to put in a third one. The canal passes through gypsum beds in a number of places, and in each of these it had to be replaced by wooden flumes, which are in turn being replaced by earth and gravel bottoms. The canal is now rapidly being returned to its former good condition.

This canal is owned and controlled by La Verkin Bench Canal Company, which was incorporated May 5, 1902, with a capital stock of $15,000, divided into 600 shares, each of which is intended to represent a right to water for 1 acre. Since 1902 the company has been in substantial shape. All of the land under the canal has been sold and 400 acres were watered during 1902. The water is distributed on a time basis so as to cover the whole area once in twelve days.

La Verkin Bench has an elevation of 3,200 feet and is adapted to the growth of fruit and vegetables. These are the principal products, although alfalfa and grain will also be grown. The annual assessment for canal maintenance is $1.25 per acre.

### HURRICANE BENCH.

The movement that will end in the irrigation of Hurricane Bench, across Virgin River and directly south of La Verkin Bench, is one of the most enterprising connected with the history of Virgin Valley. It embodies the construction by men

FIG. 1.—HURRICANE DAM IN VIRGIN RIVER.

FIG. 2.—SECTION OF HURRICANE DAM.

without other capital than muscle and determination, of 5 miles of canal along the precipitous and rocky cliffs of Virgin River Canyon, directly above La Verkin Bench, and 3 miles of canal whose construction has been less difficult. This work was begun in the winter of 1893–94, after discussion extending over a period of thirty years. If the intention of the builders is carried out, it will be so far completed by the spring of 1903 as to permit of the beginning of irrigation and cultivation on Hurricane Bench. Construction work has been carried on each winter and continued into each summer, as those interested could leave their small farms in the surrounding settlements. On October 1, 1902, $54,000 had been expended, of which about $50,000 was in labor. On that date the total stock subscribed was $64,450. Prior to February 1, 1902, the builders of the canal had received no assistance from any source, but on that date the authorities of the Mormon Church subscribed for $5,000 in stock, which is being paid in cash to those working on the canal. The total cost of the canal is estimated at $65,000, which will make the cost of water on Hurricane Bench fully $50 per acre.

This undertaking has been carried on, not as an investment, but solely to create homes for the sons and daughters of the early settlers in the upper Virgin River towns. The power of these towns to support increased populations was exhausted, and without the new homes which Hurricane Bench or some similar tract would supply the younger generation would have been compelled to seek a livelihood outside the chosen valleys of their fathers. As in any undertaking of this magnitude, discouragements have been encountered from the beginning. Although the land to be watered was not filed on until two years after work on the canal was begun, it was found impossible to meet the conditions of the desert-land act, under which the filing was made, and get water to the land within the required four years; whereupon the land and the first payment of $500 reverted to the Government. Fees to the United States Land Office and to attorneys to the extent of $200 were also lost. Since construction began, from thirty to forty of those interested have become discouraged and have sold their credits for labor for whatever they would bring. These credits have been purchased by the few men of some means connected with the enterprise, who were expected, instead, to hire their shares worked out by those stockholders who needed financial assistance. Losses have also resulted from faulty surveys of the land to be watered. Besides, those who were working out the price of their shares have suffered through frosts in their home settlements, and have consequently been compelled to seek work with a cash rather than a credit income.

As already stated, Hurricane Canal heads in Virgin River 4 miles above La Verkin Bench. Directly at the mouth of a box canyon, whose sides and bottom are of solid rock, a dam of logs and rock has been placed across the river (Pl. XVI, fig. 1). Beginning a short distance from the dam, heavy construction was encountered for 5 miles. The formation passed through is principally conglomerate and lime rock. Gypsum has been encountered in only one short section. Nine tunnels, with a total length of 61 rods, and a number of rods of flume, have carried the canal through or around the most precipitous cliffs. In some cases rock fills (Pl. XVI, fig. 2), whose permanence is at best doubtful, have been substituted for costly excavation, not because they were deemed satisfactory, but because of the limited means of the builders. For the first 4 miles the canal has a grade of one-fourth inch, and below

that one-eighth inch to the rod. It has a bottom width of 8 feet, a top width of 10 feet, and a depth of 4 feet. Its projected length is 6¼ miles.

Those who are building the canal have incorporated the Hurricane Canal Company, with a capital stock of "2,000 shares of primary water right, 1 acre of water right constituting a share of the par value of $40." In 1901, after the filing under the desert-land act lapsed, four stockholders in the company made application to the State land board for the selection of the land by the State and its sale to them. The selection was made and 1,440 acres under the canal purchased in trust for the Hurricane stockholders. It is the intention to purchase 320 acres additional, making 1,760 acres in all. This land will remain in the names of the purchasers until paid for, when it will be deeded to the individual stockholders. The price to be paid the State is $1.25 per acre, of which 25 cents was paid at the time of the selection, the remainder to be paid in ten annual installments. Each share in the company entitles its holder to 1 acre in the tract and water for it. In April, 1902, 1,400 shares had been taken by 75 individuals, in holdings ranging from 15 to 40 acres. The bench will be surveyed into 10-acre holdings and distributed by lot, except the town site, which will contain 4½-acre blocks. The land in the fields is similar to that of La Verkin Bench, directly north across the Virgin River. It is at present heavily grown with greasewood and black sagebrush. The success with fruits on La Verkin Bench has been an encouragement to the Hurricane shareholders, for it is expected that fruit will be among the chief products grown.

### REMAINING SETTLEMENTS IN THE CENTRAL DIVISION.

The remaining settlements in the central division are small, the largest—Washington—having but 500 inhabitants, and the smallest, such as Atkinville and Duncans Retreat, containing but one or two families. They are on Virgin River, extending throughout the length of the central division; on Santa Clara Creek, above the St. George Clara fields; on the benches east of St. George, and on Quail, Ash, Kanarra, La Verkin, and North creeks. Practically all of the water of the tributary creeks is used before it can reach the river. Excepting the Muddy in the lower division, Santa Clara Creek is the principal tributary. It rises in Pine Valley Mountains, in the northern part of Washington County, and flows into Virgin River 2 miles south of St. George. Barring flood water in some years and the water diverted by the Seep Ditch, all of the water in the creek is used above its mouth. Quail Creek, which rises on the southeast side of Pine Valley Mountains, is completely diverted at Harrisburg and Leeds. Ash Creek, also rising in Pine Valley Mountains, is all used in the settlements of Harmony, Bellevue, and Toquerville, each of these settlements in turn having an independent supply. No water of Kanarra Creek, which rises in the mountains east of Kanarraville, passes the town, although the creek is naturally tributary to Ash Creek. La Verkin Creek is a part of the supply of Toquerville. North Creek, excepting in the early spring, when some of the surplus water is diverted by the Virgin City Upper Town Ditch, supports only the two small settlements of Mountain Dell and The Mill. During the season of 1902 the conditions of agriculture and the extent of irrigation in each of these settlements were examined, and some of the principal data gathered in the examination are given below:

BLOOMINGTON.

In this settlement situated on the river below St. George, 190 acres, in average holdings of 12 acres, is watered by the Bloomington Irrigation Company's ditch, taking water from Virgin River, and using also some seepage water from Santa Clara Creek early in the season. The ditch is 2 miles long and the water supply is generally sufficient.

PRICE.

The Price Field Irrigation Company takes water from the Virgin River below St. George, for 184 acres in average holdings of 11.5 acres. The ditch is 3 miles long, and the annual cost of water is from $8 to $10 per acre. The organization controlling the water has recently lapsed.

ATKINVILLE.

At Atkinville on the river valley below Price, William Atkin waters 120 acres through a private ditch 1.5 miles long.

SANTA CLARA.

This settlement is on Santa Clara Creek. The Santa Clara Field Company controls six small ditches which water 455 acres in average holdings of 10.5 acres. Water is distributed by time rotation. The supply is very short, and the cost is from 75 cents to $1 per acre per annum.

GUNLOCK.

Gunlock is also located on the Santa Clara. Nine small ditches distribute water to 105 acres in average holdings of 10 acres. The water supply is short, and costs about 50 cents per acre per annum.

PINE VALLEY.

Pine Valley is near the headwaters of Santa Clara Creek. A generally sufficient supply of water is supplied to 623 acres by seven ditches, at an annual cost of 50 cents per acre. The average size of holdings is 20 acres. In June, 1902, when the Santa Clara was normal, the snow in the Pine Valley Mountains having melted, water was flowing into the valley from all sources as follows:

| | Cu. ft. per sec. |
|---|---|
| Main creek, one-fourth mile above Pine Valley Upper North Ditch | 5.25 |
| Spring Branch, 100 yards below spring | 2.59 |
| Forsyth and Lloyd canyons | 1.00 |
| Total | 8.84 |

A gauging of the stream made below all tributaries and below the fields on the same day showed 2.61 cubic feet per second to be passing out of the valley. Deducting this from the amount entering the valley from all sources gives 6.23 cubic feet per second as being used in the valley. This gave a duty at the beginning of the irrigation season of 1 cubic foot per second to each 100 acres. Only the hardier products can be raised in this valley, on account of the altitude.

SHEBITS INDIAN FARM.

This farm of 80 acres is watered by three ditches from Santa Clara Creek. The water supply is short and the cost is nominal.

MAGOTSA.

Seventy-eight acres in this settlement, located above the junction of Magotsa and Santa Clara creeks, is watered by six ditches from Magotsa Creek and Moody Wash. The water supply is good.

HUNT'S, CHADBURN'S, AND FOSTER'S FARMS.

These farms, containing 46 acres, are on Santa Clara Creek, 15 miles above Gunlock. There are three ditches, with a total length of 1.5 miles.

GRASS VALLEY.

This settlement contains 103 acres on Grass Valley Creek, west of Pine Valley. The holdings average 25.75 acres. There are four ditches having a total length of 3 miles. The supply is generally sufficient.

### MIDDLETON.

Middleton, 2 miles east of St. George, gets water from Middleton Springs, for 35 acres, in holdings of 8.75 acres. There is no organization, and the annual cost of water is about 15 cents per acre.

### WASHINGTON.

Washington is 5 miles east of St. George. The water supply comes from springs and Mill Creek, and is controlled by the town council of Washington and the Mill Creek Water Company. Water is distributed to 325 acres, by rotation. There are six ditches, having a total length of 4.5 miles. The water supply is generally sufficient.

### HARRISBURG AND LEEDS.

These settlements are on Quail Creek. The Leeds Water Company controls the water to irrigate 30 acres at Harrisburg and 230 acres at Leeds. Three ditches, having a total length of 7 miles, furnish a generally sufficient supply of water. June 18, 1902, Quail Creek was carrying 4.97 cubic feet per second at Silver Reef above the division of the water to Harrisburg and Leeds.

### ANDERSONS.

The Anderson Ditch waters from 1 to 150 acres from a spring, the area depending on the water supply, which is short. Fifty acres of orchard and vineyard received no water from January 1, 1900, to June 1, 1901, but were kept alive and thrifty by intensive cultivation.

### HARMONY.

Harmony is located on the headwaters of North Ash Creek, and gets its water from that stream and springs. Nine ditches, with a total length of 5.5 miles, supply water to 305 acres in average holdings of 16 acres, at an annual cost of 50 to 75 cents per acre. On June 19, 1902, the following gaugings were made of Ash Creek, Lawson Spring, and Harmony Town Ditch, leading from Comanche Spring:

| | Cu. ft. per sec. |
|---|---|
| North Ash Creek, 100 feet above upper dam below Harmony | 1.04 |
| Lawson Spring Ditch, 200 yards below spring | .65 |
| Harmony Town Ditch, at edge of F. Prince's field | .49 |
| Total | 2.18 |

When these gaugings were made, Lawson Spring and Comanche Spring were normal. The main stream was approximately one-third of its flow April 15, 1902, when irrigation began, and twice the midsummer flow. The lowest duty of the water is therefore approximately 1 cubic foot per second to each 70 acres, and the highest duty 1 cubic foot per second to each 180 acres at Harmony.

### KANARRAVILLE.

The Kanarra Field Reservior and Irrigation Company supplies water from Kanarra Creek to 350 acres, the average holdings being 12 acres. The water supply is very short. Water is delivered by time rotation, each acre receiving water two and one-half to four hours once in eight days. On June 19, 1902, Kanarra Creek was carrying 1.72 cubic feet per second, which was said to be the lowest flow for ten years, from one-fifth to one-tenth of the usual spring flow, and one-half of the usual summer flow. Because of the shortage, but 175 acres were being watered.

### BELLEVUE.

Bellevue is located at the junction of South Ash and Ash creeks. The area irrigated is 75 acres in average holdings of 19 acres. On June 20, 1902, South Ash Creek was carrying 2.22 cubic feet per second, which was one-half the spring flow and twice the flow about August 1.

### TOQUERVILLE.

This settlement is on Ash Creek. Three hundred and fifty acres in average holdings of 6.5 acres are watered from Ash Creek and La Verkin Creek by six ditches, having a total length of 3 miles. The

FIG. 1.—VALLEY OF VIRGIN RIVER BETWEEN ROCKVILLE AND GRAFTON

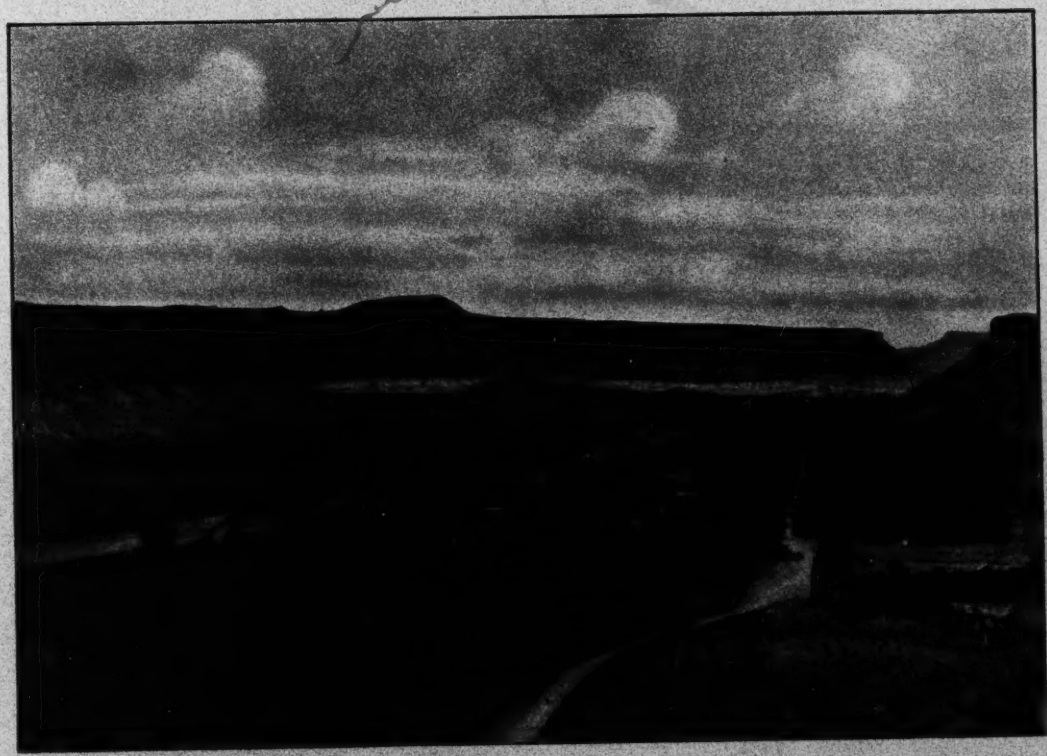

FIG. 2.—VALLEY OF VIRGIN RIVER, SHOWING ROCKVILLE TOWN AND FARMING LANDS.

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Toquerville Irrigation Company controls the town and east side ditches. Each acre receives water two and one-half to four hours every eight days. The west side and La Verkin Creek ditches are not organized. The annual cost of water in the settlement is about $1 per acre.

VIRGIN CITY.

This settlement is on the Upper Virgin River. Six ditches supply water to 227 acres in average holdings of 7 acres, the annual cost being $4.25 per acre. The supply is ample, but the cost is large, owing to the sand filling the ditches. The water users are not organized, but the principal ditches have each a secretary and a water master.

MOUNTAIN DELL AND THE MILL.

These settlements are on North Creek. One hundred and thirty acres in average holdings of 12 acres are watered by twelve ditches at a merely nominal expense. The water supply is short in June and July.

DUNCANS RETREAT.

Four acres are watered at this place on the Upper Virgin River. The water supply is ample and the cost is merely nominal.

GRAFTON.

This settlement takes water from the river through two ditches. (Pl. XVII, fig. 1.) An area of 154 acres in average holdings of 8.5 acres is watered at a cost of from $1 to $3 per acre per annum. Each acre receives an irrigating stream from two to four hours every eight or ten days. There is no formal organization, but each ditch has a water master and a secretary.

ROCKVILLE.

Rockville is the only settlement on Virgin River in which a strict time-rotation system of distribution is not followed. As there is abundant water in the river at Rockville, no strict regulation is exercised over the amount of water used. Three ditches serve 293 acres at a cost per acre of from $1 to $2.50 per year. (Pl. XVII, fig. 2.) Land holdings average 9 acres.

SPRINGDALE.

Springdale is on Zion Creek. Two ditches water 160 acres in average holdings of 8 acres, the cost per acre being $1 per year. Above Springdale, Zion Creek, seven ditches water 135 acres in average holdings of 8 acres. The water supply is ample and the cost is very small.

SHUNESBURG.

Only 35 acres are watered at Shunesburg. An ample water supply is taken from Virgin River.

## CROP RETURNS FOR THE CENTRAL DIVISION.

The data covering the crop returns in the St. George and Washington and the St. George Clara fields have already been given (see page 218). In addition an effort was made to learn the yield and value of crops in the other settlements of the central division of the basin. It was impracticable to gather detailed reports of actual yields in these settlements, but, instead, estimates were obtained from several of the leading farmers in each settlement. Although each farmer consulted was asked for a conservative estimate, it is natural for the figures given to more nearly represent good than average years.

The following summary contains averages of the estimates obtained in each settlement, and also shows the principal crops grown:

*Summary of crop returns in settlements of central division of Virgin River Basin.*

| Settlements. | Principal products grown. | Average yield per acre. | Return per acre. | Average return per acre for settlement. |
|---|---|---|---|---|
| Bloomington and Price | Alfalfa | 4 tons | $24.00 | $23.25 |
| | Wheat | 25 bushels | 22.50 | |
| Santa Clara | Alfalfa | 5 tons | 30.00 | 31.58 |
| | Wheat | 25–30 bushels | 24.75 | |
| | Barley | 50 bushels | 40.00 | |
| Gunlock | Alfalfa | 5 tons | 35.00 | 35.00 |
| Pine Valley | Alfalfa | 2 tons | 18.00 | 31.07 |
| | Wheat | 20 bushels | 18.00 | |
| | Oats | 38 bushels | 30.40 | |
| | Potatoes | 150 bushels | 60.00 | |
| Grass Valley | Alfalfa | 2 tons | 20.00 | 28.12 |
| | Wheat | 25 bushels | 22.50 | |
| | Oats | 40 bushels | 30.00 | |
| | Potatoes | 100 bushels | 40.00 | |
| Harrisburg and Leeds | Alfalfa | 5 tons | 30.00 | 30.00 |
| | Wine grapes | 200 gallons | a 100.00 | |
| Harmony | Alfalfa | 4 tons | 28.00 | 30.30 |
| | Wheat | 25 bushels | 22.50 | |
| | Oats | 40 bushels | 28.00 | |
| | Barley | do | 28.00 | |
| | Potatoes | 100 bushels | 45.00 | |
| Kanarraville | Alfalfa | 4 tons | 32.00 | 39.40 |
| | Wheat | 25 bushels | 22.50 | |
| | Barley | 50 bushels | 37.50 | |
| | Oats | 40 bushels | 30.00 | |
| | Potatoes | 150 bushels | 75.00 | |
| Bellevue | Alfalfa | 4 tons | 32.00 | 32.00 |
| Toquerville | Alfalfa | 3½ tons | 17.50 | 32.50 |
| | Wine grapes | | 50.00 | |
| | Sorghum | 100 gallons | 30.00 | |
| Virgin City | Alfalfa | 2 tons | 10.00 | 22.50 |
| | Sorghum | 100 gallons | 35.00 | |
| Grafton | Alfalfa | 3 tons | 15.00 | 26.50 |
| | Sorghum | 125 gallons | 37.50 | |
| | Wheat | 30 bushels | 27.00 | |
| Rockville | Alfalfa | 4 tons | 20.00 | 28.33 |
| | Wheat | 35 bushels | 30.00 | |
| | Sorghum | 100 gallons | 35.00 | |
| Springdale | Alfalfa | 3 tons | 18.00 | 20.25 |
| | Wheat | 25 bushels | 22.50 | |
| Mean | | | | 29.38 |

a Acreage small and not counted in average.

The above summary shows the mean annual return per acre for the settlements in the basin, outside of the St. George and Washington and the St. George Clara fields, to be $29.38. Although believed to fairly represent the returns from farming in the basin, this mean is not necessarily accurate, because the average returns for each settlement would be larger or smaller according to the acreage planted to the

different products. In most of the settlements farm produce does not yield a cash return, and consequently the prices used in figuring the returns are based on the market values in the vicinity. Such produce as fruits, vegetables, and sorghum are usually peddled in the adjoining counties as far north as the Sevier Valley, and in the mining camps around St. George, and in Lincoln County, Nev. Until recent years the peddling was mostly by barter, a gallon of molasses or wine going for a bushel of wheat, and fruits and vegetables being exchanged for household provisions. When wheat came to have a cash value in the northern settlements and molasses came to be imported from outside States, the purchasing power of the latter became so diminished that the settlers along the Virgin River found it more profitable to raise wheat than sorghum, and consequently the area now devoted to sorghum is small.

### LAND AND WATER VALUES IN THE CENTRAL DIVISION.

Land and water values vary in the different settlements of the central division of the basin, according to the scarcity or abundance of either one. In the upper settlements on Virgin River—Virgin City, Grafton, Rockville, Springdale—water is so abundant as to have no cash value, but land is so scarce as to be in demand, although not at a high figure. In the St. George and Washington Field land and water together change hands constantly at from $25 to $50 per acre, of which $12 to $15 represents the price of the water. On the lower Santa Clara Creek bottoms the two are seldom separated, but together bring from $50 to $100 per acre. In the smaller settlements land and water together are considered worth from $25 to $60 per acre, with little changing hands.

### WATER TITLES IN THE CENTRAL DIVISION.

Water titles in the central division of the basin of Virgin River have, except on Santa Clara Creek, received no serious consideration. This is because, until recently, development had not reached the point that made it necessary. On some of the tributaries of the Virgin River, and on some sections of the main stream, agreements between the farmers, based on continued usage, and awards by the county selectmen sitting as water commissioners under the law of 1880, have settled common opinion as to what the rights are and in many cases furnished a basis for finally establishing them. Establishing rights through litigation has not been generally followed. The founding of the southern settlements by a people of one faith enabled the settlers to divide the water as a rule satisfactorily. Their practical sense told them how much land the small streams would water, and this land was straightway tilled, yet this knowledge did not prevent their allowing another 50 or 100 acres to be taken up under the same stream by another of their faith who wished to cast his lot with them. So the watered areas were gradually widened and the available water for each acre lessened, until some of the smaller springs and tributaries came to support populations that severely taxed them. Misunderstandings there were, of course; but the net result was for contentment and progress. If individuals could not reach an agreement the Mormon Church authorities could. When the Territorial legislature constituted the county selectmen guardians of the streams, the farmers appeared before them for certificates of water as they did for range and milling privileges, and

the county court appointed water masters as it did tax collectors. When the judges of the districts north began to hold the awards of the county selectmen invalid, the farmers on Virgin River were too far away to know it, and to this day many of them will draw their "water" from their vest pocket with assurance of absolute possession and ownership. When, in 1865, the law authorizing irrigation districts was passed, one was straightway formed embracing the valley of the Santa Clara, and efforts were made to form them at Washington and Springdale. When the districts failed, the practice common in the north of protecting rights by incorporating the irrigation interests in the different settlements was taken up, and this is the stage being passed through to-day.

It has already been stated that because the water in the river does not pass in the dry season from one division to another, water titles in each of the three agricultural divisions of the Virgin Basin are practically independent of water titles in the other two. This fact makes it desirable to follow the plan used in discussing agricultural conditions and to consider water titles in the three divisions separately.

To make the discussion clear, it will be repeated here that what is called the central division of Virgin River is that between the narrows in Zion Creek and East Fork canyons, above the towns of Rockville, Springdale, and Shunesburg, and the narrows in the river below St. George. It embraces St. George, Bloomington, Price, and Atkinville, on the river below St. George; the valley of Santa Clara Creek, including Santa Clara, Shebits Indian Farm, Gunlock, Magotsa, Pine Valley, and Grass Valley; Washington and Middleton; Harrisburg and Leeds, on Quail Creek; Kanarraville, Harmony, Bellevue, and Toquerville, on Ash and Kanarra creeks; La Verkin; the proposed Hurricane settlement; Virgin City, North Creek, Grafton, Rockville, and Springdale. Excepting Zion Creek, none of the tributaries discharges water into Virgin River during the dry season and only small amounts during the remainder of the year. They have consequently always been considered independent of the Virgin, and they will be so considered in this discussion and taken up separately.

### ON VIRGIN RIVER.

The settlements on Virgin River in the central division, beginning with those highest on the stream, are: Springdale, Shunesburg, Rockville, Grafton, Virgin City, Hurricane Bench, La Verkin Bench, St. George, Bloomington, Price, and Atkinville. The canals and ditches furnishing water to these settlements, arranged in order, commencing at the head of the stream, follow:

*Summary of canals and ditches taking water from Virgin River in central division.*

| No. | Name of canal or ditch. | Location. | Area watered. |
|---|---|---|---|
| | | | *Acres.* |
| 1 | Zion Ditch | Above Springdale | 41 |
| 2 | Flanigan Ditch | do | 7 |
| 3 | Roesch Ditch | do | 7 |
| 4 | Windows Ditch | do | 40 |
| 5 | Crawford Ditch | do | 40 |
| 6 | Flanigan Ditch | do | 120 |
| 7 | Springdale Upper Ditch | Springdale | 90 |

*Summary of canals and ditches taking water from Virgin River in central division.*—Continued.

| No. | Name of canal or ditch. | Location. | Area watered. |
|---|---|---|---|
| | | | Acres. |
| 8 | Springdale Lower Ditch | Springdale | 64 |
| 9 | Shunesburg West Ditch | Shunesburg | 15 |
| 10 | Shunesburg East Ditch | ....do | 7 |
| 11 | Shunes Creek Ditch | ....do | 7 |
| 12 | South Creek Ditch | ....do | 6 |
| 13 | Rockville Town Ditch | Rockville | 225 |
| 14 | Rockville South Ditch | ....do | 52 |
| 15 | Dalton Ditch | ....do | 6 |
| 16 | Grafton Town Ditch | Grafton | 70 |
| 17 | Grafton Lower Ditch | ....do | 84 |
| 18 | Duncan Ditch | Above Virgin City | 4 |
| 19 | Upper Farming Land Ditch | Virgin City | 52 |
| 20 | Farming Land Ditch | ....do | 91 |
| 21 | Virgin City Upper Town Ditch | ....do | 32 |
| 22 | Virgin City Lower Town Ditch | ....do | 44 |
| 23 | Lee & Spendlove Ditch | ....do | 10 |
| 24 | Wright and Isom Ditch | ....do | 7.5 |
| 25 | Hurricane Canal | Hurricane Bench | ..... |
| 26 | La Verkin Canal | La Verkin Bench | 400 |
| 27 | D. Spillsbury Ditch | Above mouth of Ash Creek | 8 |
| 28 | L. Savage Ditch | ....do | 6 |
| 29 | Pollock Ditch | Above St. George and Washington Dam | 55 |
| 30 | Prince & Wilkinson Ditch | ....do | 85 |
| 31 | St. George and Washington Canal | Above St. George | 2,175 |
| 32 | Jarvis Ditch | ....do | 200 |
| 33 | Bloomington Ditch | Bloomington | 190 |
| 34 | Price Ditch | Price | 184.5 |
| 35 | Atkinville Ditch | Below Price | 120 |
| | Total | | 4,531 |

The above summary includes every ditch, however small, taking water from Virgin River in the central division of the stream, including Zion Creek, during the irrigation season of 1902. It shows thirty-five ditches, watering a total of 4,531 acres. It would seem that before so many ditches could have been built some orderly and lasting system of acquiring water rights would have been established, if not on demand of the public, then at least on demand of individuals using water. Yet of the thirty-five ditches not one has been decreed a right to the water it diverts, nor has one a right whose title is in the least certain. There is not even the usual dependence on posting notices and filing claims. Although the laws of Utah provide[a] that those desiring to appropriate water shall, within twenty days after making the appropriation, file a notice of the appropriation with the clerk of the county in which the appropriation is made, the records of Washington County show but few claims to water from Virgin River. Those which are on file are given in the following summary:

*Claims to water from Virgin River on file in Washington County.*

February 13, 1878, Mat Magney and George Buckner. They claimed all the water of Virgin River from and above secs. 25 and 26, T. 41 S., R. 13 W. for irrigation.

[a] Revised Statutes of Utah, 1898, par. 1260.

January 12, 1899, Thomas Judd and E. V. Hardy claimed 1,500 miner's inches, for irrigation, on La Verkin Bench.

January 9, 1899, Washington Field Canal Company claimed 3,500 inches, for irrigation, to be used through the Washington Field Canal.

January 15, 1899, Thomas Judd claimed all the water of Virgin River not claimed by La Verkin Fruit and Nursery Company, for milling and mining. A similar notice by the same parties was filed October 18, 1900.

April 24, 1894, Thomas Judd and R. G. McQuarrie claimed all of Sulphur Springs in Virgin River, for bathing purposes.

There is nothing in the county record to show that any of the claims enumerated above have ever been made good by actual appropriation and use. By an examination of the stream it was learned that there have been appropriations under the claims filed for La Verkin Bench, the Washington Canal, and for bathing purposes only.

Many of the ditches included in the summary on pages 228, 229 were awarded water by the county selectmen. These awards were usually made to the individuals under the ditches rather than to the ditches. The awards were mostly made during the first ten years after the law authorizing such awards was passed, yet authority to make awards was considered to be vested in the county commissioners until 1895, when the application of Hurricane Canal Company for a primary right to 4,000 inches from Virgin River was considered and refused on the grounds that the awards already made exhausted the stream in low water. While these awards in no sense established title, they have some value as evidence regarding the time and amount of early appropriations. Therefore the records of the county commissioners' courts were searched for a list of them. The records found were very incomplete. Nine awards to Virgin River were entered. Of these, one dated August 7, 1881, gave D. McMullin a primary right for 15 acres and a secondary right for 15 acres; one dated August 7, 1881, gave D. and G. McMullin a primary right for 9 acres and a secondary right for 9 acres; one dated August 7, 1881, gave W. Laney a primary right for 7 acres and a secondary right for 2 acres; two dated March 7, 1882, gave A. J. Workman a primary right for 4¼ acres; one dated March 7, 1882, gave W. D. Johnston a primary right for 1 acre; one dated June 2, 1891, gave Bloomington Irrigation Company a primary right to 275 inches; one dated June 2, 1891, gave Price Irrigation Company a primary right to 1,200 inches, and one dated August 8, 1893, gave the Washington Field Canal Company a primary right to 3,500 inches. The records at Kanab show also that rights were given to Levi Savage for 20 acres at Toquerville; to the Virgin City Farming Land Ditch for 132.5 acres; to Virgin City Parker Ditch for 10 acres; to Virgin City Lower Ditch for 50 acres; to Grafton Ditch for 125.5 acres, and to Rockville Ditch for 280 acres. The awards shown by the record are not all that were made, a number of other individuals in the upper settlements holding certificates to small amounts, showing either that all awards were not entered or that some of the records have been lost. The record is, therefore, so incomplete as to have but little value when it comes time to settle the rights on the central division of the river.

After the law of 1901 authorizing the county commissioners to appoint water commissioners was passed, that section of the river designated in this report as the central division was constituted water division No. 1, in Washington County,

and a water commissioner was appointed. How this water commissioner was to distribute the water of Virgin River to 35 ditches when not one of them, or not one of the individual irrigators under them, had an established title to water is not clear, yet that was the task set him. Fortunately the irrigators from Virgin River are endowed with a propensity to peace, and are fairly well agreed as to their own and their neighbors' rights. The commissioner has rarely, if ever, been called upon to make any division, and consequently the need for a definite basis of division has not been strongly felt.

Within a short time an increased demand for water from the river will make a definite settlement of rights, if not absolutely necessary, then at least highly desirable. The stage has already been reached when the irrigators wish to know and have tangible evidence of what their rights are. The establishment of these rights is not a difficult task, yet it will require care and thoroughness in its accomplishment. The problem that is now giving the most concern is whether there will be sufficient water in the river to cover the land under the new Hurricane Canal without causing a shortage in the lower canals. The Hurricane farmers claim only a secondary right, yet they have spent so much time and effort on their enterprise that failure in the water supply would be serious. During the progress of the canal the theory has been held that water diverted to Hurricane Bench at the season the supply in the river is ample will seep back to the river at the season the river is lowest, thus being a benefit rather than an injury. While such a result has followed diversions on many streams, as for instance the Sevier (see page 268), there seems little reason for believing that it will follow to any great extent in the case of the Hurricane enterprise. The Hurricane land is bench land of volcanic origin with no clearly defined dip toward the river. The character of the subsoil of the bench is unknown. The land to be watered is from one-half to 3 miles from the river. It is doubtful, therefore, whether the water diverted to the bench will return to the river in time to be of any value to the irrigators below. Even if the theory of the Hurricane farmers proves incorrect, it would seem that, if handled wisely, there is ample water in Virgin River to meet all present needs and also to supply those of Hurricane Bench. To determine if this is the fact, a daily record of the flow of the river was kept during the season of 1902 at La Verkin Sulphur Springs (see page 209). This record, computed in acre-feet, is given in the following table of discharges:

*Estimated discharge of Virgin River at La Verkin Sulphur Springs during irrigation season of 1902.*

| Day. | March. | April. | May. | June. | July. | August. | September. | October. |
|---|---|---|---|---|---|---|---|---|
| | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* |
| 1 | | 218.91 | 228.13 | 121.98 | 80.56 | 528.25 | 478 | 301.60 |
| 2 | | 241.97 | 356.20 | 82.09 | 80.56 | 508.74 | 459.20 | 267.60 |
| 3 | | 228.13 | 418.50 | 108.14 | 45.12 | 519.06 | 459.20 | 199.35 |
| 4 | | 228.13 | 320.32 | 108.14 | 62.88 | 519.06 | 437.85 | 180 |
| 5 | | 228.13 | 301.46 | 82.08 | 62.88 | 497.45 | 478 | 186.50 |
| 6 | | 241.97 | 261.31 | 62.88 | 80.56 | 497.45 | 478 | 141.80 |
| 7 | | 282.68 | 241.97 | 62.88 | 56.88 | 508.10 | 497.86 | 141.80 |
| 8 | | 377.80 | 281.61 | 62.80 | 80.56 | 556.86 | 459.20 | 122 |
| 9 | | 301.46 | 241.97 | 112.66 | 62.88 | 578.45 | 468.10 | 122 |
| 10 | | 320.32 | 228.13 | 62.88 | 39.01 | 578.45 | 478 | 141.80 |
| 11 | | 301.46 | 182.47 | 67.90 | 80.56 | 556.86 | 478 | 182.90 |

*Estimated discharge of Virgin River at La Verkin Sulphur Springs during irrigation season of 1902*—Cont'd.

| Day. | March. | April. | May. | June. | July. | August. | September. | October. |
|---|---|---|---|---|---|---|---|---|
| | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* | *Acre-feet.* |
| 12 | ..... | 450.17 | 223.13 | 72.64 | 50.56 | 578.45 | 478 | 166.50 |
| 13 | ..... | 377.50 | 223.13 | 62.89 | 45.12 | 568.07 | 459.20 | 132.90 |
| 14 | ..... | 327.66 | 135.52 | 50.56 | 39.01 | 776 | 459.20 | 151.75 |
| 15 | ..... | 349.09 | 135.52 | 62.89 | 50.56 | 835.01 | 519.06 | 141.80 |
| 16 | ..... | 356.50 | 131.90 | 59.94 | 50.56 | 716.01 | 508.10 | ..... |
| 17 | ..... | 377.50 | 135.52 | 56.56 | 62.88 | 657 | 459.20 | ..... |
| 18 | ..... | 459.16 | 168.09 | 56.56 | 62.88 | 578.45 | 418.50 | ..... |
| 19 | ..... | 399.14 | 166.09 | 39.01 | 62.88 | 556.88 | 459.20 | ..... |
| 20 | 206.87 | 578.42 | 166.09 | 45.12 | 50.56 | 578.45 | 478 | ..... |
| 21 | 292.26 | 360.32 | 166.09 | 50.56 | 62.88 | 519.06 | 478 | ..... |
| 22 | 241.97 | 301.48 | 153.71 | 62.88 | 50.56 | 478 | 478 | ..... |
| 23 | 223.13 | 327.66 | 153.71 | 56.56 | 21.50 | 377.50 | 418.50 | ..... |
| 24 | 261.31 | 320.32 | 153.71 | 56.56 | 39.01 | 399.17 | 398.15 | ..... |
| 25 | 241.97 | 339.15 | 156.71 | 45.12 | 103.14 | 418.50 | 301.48 | ..... |
| 26 | 261.31 | 356.20 | 182.47 | 39.01 | Flood. | 519.06 | 301.48 | ..... |
| 27 | 282.66 | 339.15 | 103.14 | 30.01 | 734.90 | 497.45 | 320.32 | ..... |
| 28 | 282.03 | 339.15 | 135.52 | 50.56 | 657 | 657 | 339.15 | ..... |
| 29 | 261.31 | 356.20 | 163.29 | 50.56 | 657 | 616.56 | 339.15 | ..... |
| 30 | 213.21 | 356.20 | 172.95 | 72.64 | 657 | 556.84 | 339.15 | ..... |
| 31 | 213.21 | ..... | 163.29 | ..... | 582.64 | 519.06 | ..... | ..... |
| Total | 2,961.31 | 9,997.92 | 6,228.37 | 1,958.75 | 4,622.59 | 17,302.31 | 13,065.32 | 2,512.40 |

The year of 1902 has been one of the driest on record, yet 58,692 acre-feet passed Virgin City to the ditches below between March 20 and October 15. This was sufficient to cover all of the irrigated land under the ditches below Virgin City as well as the 2,000 acres on La Verkin and Hurricane benches, which have as yet received no water, to a depth of 10.87 feet. As shown in discussing the climate of Virgin Valley and the character of the river channel, a large loss through evaporation and seepage must be counted on. It would seem conservative to estimate that two-fifths of the stream could be saved. This would cover the irrigable land under ditch not yet irrigated to a depth of 4.35 feet, which is certainly sufficient to produce crops even in Virgin Basin. Sufficient water to meet all needs can not be saved, however, without more economical use of water than is made now. Seepage losses in canals will have to be lessened, more of the water used for sluicing will have to be saved, and a higher duty of water when applied to the land will have to be reached. A striking example of extravagant use is presented by St. George and Washington Field. Enough water was used on that field during the season of 1902 to cover the land irrigated to a depth of 8.41 feet, nearly double the amount that should be necessary (see page 217). That it was far in excess of the needs of the land is shown by the fact, reported by the president of the company, that 200 acres in the field have been rendered useless and 300 acres additional very much injured by the rise of alkali in the land, due to overirrigation on the higher lands of the field and seepage from the near by canal and laterals. Out of the 119 farmers watering land in the field in 1902, 56 reported damage by alkali, their crops being cut down from one-eighth to three-fourths. There is no excuse for wasting water where it is as valuable and where its loss means so much as in Virgin River Basin.

From Virgin City up, the farmers on the river have thus far been practically independent of those below. There land, and not water, determines values. A shortage in the Virgin River at these settlements has never been known, and on only one or two occasions have complaints of excessive use in these settlements been made by those below. On those occasions committees of lower settlers have made the request that for a few days the entire flow of the river be allowed to pass to the canals and ditches farther down. Such requests have always been granted, yet it is an interesting fact that there is on record no occasion on which the shortage that was the reason for such a request has not been removed by the coming of a flood almost before the complaining committees had returned. Because the upper settlements have thus far been independent is no reason for their remaining so. They should be allowed to lessen the flow of the river only so far as is necessary for the irrigation of their land. Although much of the excess water used in the upper settlements returns to the river, it is still true that a large percentage is lost by evaporation in the frequent and wasteful floodings. A series of measurements of the effect of the upper diversions on the flow of the river was made in the summer of 1902. The flow of Virgin River both above and below Virgin City and Rockville, and also of the ditches at both settlements, was measured, with the results given in the following summaries:

*Measurements of Virgin River at Virgin City, June 21, 1902.*

[Cubic feet per second.]

| | | |
|---|---|---|
| Discharge above all ditches | | 42.05 |
| Discharge below all ditches | | 38.18 |
| Net decrease from diversions | | 3.87 |
| Diversions: | | |
| Lee and Spendlove Ditch | 1.59 | |
| Wright and Isom Ditch | .20 | |
| Lower Town Ditch | 1.49 | |
| Farmingland Ditch | 8.15 | |
| Upper Farmingland Ditch | 2.38 | |
| | | 13.81 |
| Gain in section due to return seepage | | 9.94 |

*Measurements of Virgin River at Rockville, June 23, 1902.*

[Cubic feet per second.]

| | | |
|---|---|---|
| Discharge above all ditches | | 49.76 |
| Discharge below all ditches | | 51.18 |
| Net increase in section | | 1.42 |
| Diversions: | | |
| Duncan Ditch | 2.37 | |
| Grafton Town Ditch | 6.48 | |
| Rockville South Ditch | 5.73 | |
| Dalton Ditch | .50 | |
| | | 15.08 |
| Gain in section due to return seepage | | 16.50 |

It is recognized that a single series of measurements is not conclusive, but these summaries show that the flow of the river was not appreciably affected by the diversions being made on June 21 and June 23. With diversions at Virgin City amounting to 13.81 cubic feet per second, there was but 3.87 cubic feet per second less water flowing away from the settlement than was flowing to it, showing that 9.94 cubic feet per second of the 13.81 cubic feet per second diverted returned to the river before the settlement was passed. With diversions at Rockville amounting to 15.08 cubic feet per second, there was 1.42 cubic feet per second more water leaving Rockville than was flowing to it, showing that while only 15.08 cubic feet per second was diverted, the gain by return seepage was 16.50 cubic feet per second. This is explained by the fact that larger diversions than those made on the days of measurement are usual and had been made a few days prior to the date of the gaugings shown in the tables. The largest ditch at Rockville—the Rockville Town Ditch, with a capacity of 10.82 cubic feet per second—and the largest ditch at Grafton—the Grafton Lower Ditch, with a capacity of 14.15 cubic feet per second—were empty on the day the gaugings were made.

When a move is made to settle water titles on Virgin River, besides determining to what extent Hurricane, La Verkin, St. George and Washington, and other canals and ditches are independent of those above, the respective rights of the irrigators in each section will have to be considered. To determine the area irrigated and the requirements of the land in the upper settlements, and the dates of use, would be a comparatively simple task, but to reach a just conclusion as to the division of water between Hurricane, La Verkin, and St. George and Washington canals would be more difficult. While the St. George and Washington Canal has been using water more systematically than La Verkin Canal, certain conditions have been met under La Verkin Canal that affect its standing. Chief of these have been the difficulties in ditch maintenance mentioned in connection with this canal earlier in this report. The question of whether reasonable diligence has been exercised by the builders of this canal would have to be considered. In determining the rights of Hurricane Canal, the question of priority would not arise, but only that of how far wasteful use elsewhere on the stream should be allowed to the injury of Hurricane Canal. The fact of wasteful use in St. George and Washington Field is clear. It should be the duty of some official, presumably the county water commissioner, to see that the wasteful use is stopped. While other fields are suffering as the Hurricane Field will when the canal is completed, no irrigator should be allowed water in excess of his needs.

After the Hurricane Canal is completed and a definite basis of dividing the water of Virgin River is established, the work of division would be greatly facilitated by a knowledge of the flow of Virgin River above Hurricane Canal. If the division is to be entirely satisfactory, this knowledge will be essential, because it is impossible to divide accurately a stream whose volume is not known. In the box canyon directly above the Hurricane Dam is a desirable section of the river for keeping such a record. An automatic register at that point would keep the record in a satisfactory and comparatively inexpensive manner, and it is to be hoped that either the owners of the different canals or the county of Washington, through the water commissioner of water district No. 1, will see their way clear to install it.

ON SANTA CLARA CREEK.

The distribution of the water of Santa Clara Creek has so far presented more difficulties than has the distribution of water in any section of Virgin River Basin. The only irrigation district successfully organized and operated in the Virgin Valley under the law of January 20, 1865, and the only litigation over water rights occurring in the central division of the basin have been in connection with this stream. Yet in spite of the difficulties met, conditions are more nearly settled on this stream than anywhere else in the basin, save in Long Valley, on the headwaters of East Fork

The cause of trouble on the Santa Clara has been twofold—the lack of any definite understanding as to what area the creek could be made to water, and unbusinesslike methods in administering the various organizations that have from time to time been charged with its control. The desire to live and let live, so prevalent with the Mormon settlers, resulted in gradual encroachments on the water supply, until in dry seasons it is insufficient. As shown in the record of discharges of the two St. George Clara ditches during 1902, the entire flow of the creek was exhausted in June. From the end of the irrigation season of 1901 to the end of the season of 1902 the only water that passed the ditches into Virgin River was that which seeped from the irrigated lands along the stream too far down to be again used. In outlining the history of the valley of Santa Clara Creek it was shown that Santa Clara was the first town to be established, that Gunlock followed Santa Clara, and that Pine Valley came last. When the missionaries were first sent south by the church authorities, the idea of making Pine Valley an agricultural settlement was not considered, and it was thought that the lower settlements on Santa Clara Creek would have an ample water supply. Pine Valley was intended primarily as a milling center, and the records of the old Washington County court have frequent reference to milling privileges allowed different settlers. Thus on September 1, 1856, the control of the water, timber, and grass in Pine Valley was granted to C. W. Dalton and others for mill purposes, and, in addition, water to irrigate 2 acres of land; and on the same day springs in Grass Valley were awarded the same parties for irrigation, "so long as their operations continue to subserve the interests of the settlement." December 3, 1867, Robert Gardiner was given a right to unite the water of Pine Valley and Hawley Springs to run a sawmill. It was not until 1866 that water came to be used to any extent for irrigation in Pine Valley. There is no record of any grant being made for such a purpose, but the early settlers remember distinctly how people from St. George gradually began irrigating the narrow bottoms in the valley, each thinking that his small diversion would work no injury to those below. The church authorities, wishing to find homes for as many as possible, urged that there was land and water for all. The natural result was that by the early seventies the irrigators began to realize that some way to retard further appropriations must be found and some agreement reached as to the division of the water.

When the city of St. George was incorporated January 17, 1862, the city council was given control of the water of Santa Clara Creek, with the provision that such control should not be exercised "to the injury of any rights already acquired by actual settlers thereon." During the controversy among the irrigators in the differ-

ent settlements there was uncertainty as to what authority the city council really had. No one knew what the rights "already acquired by actual settlers" were. September 28, 1871, a motion was made in the city council praying that the county court hold a special session for the purpose of adjudicating the rights acquired prior to the granting of the St. George charter. Instead of such an adjudication, on January 20, 1872, the uncertainty was temporarily cleared up by a compromise suggested by two of the church authorities acting on behalf of the people of Santa Clara and the city council of St. George. On the same day it was voted to form under the law of January 20, 1865,[a] the Santa Clara irrigation district, extending between certain ditches, and from the Threemile Place on Santa Clara Creek to the west side of Main street in St. George. During the next year the controversy continued, culminating in charges being filed with the church authorities against certain of the water users. Diversions above had so increased that water was scarce for domestic purposes in Santa Clara settlement. It was not until August 4, 1873, that a public election was held to decide on levying a special tax of $3.50 per acre on the land within the proposed district. The tax was carried and the district declared organized according to law. With the formation of the Santa Clara irrigation district it was supposed that the controversy would end, but it did not. August 9, 1873, it was suggested that a committee be appointed before whom every right on the stream should be proved, but no action was taken on the suggestion. October 3, 1875, a general meeting was called at the instance of the lower settlers on the creek, who could not get water for the planting of fall wheat. It was then decided to petition the church authorities to determine the rights on the stream. The petition was granted and on February 5, 1876, an agreement was submitted to the irrigators, as holders of "acquired possessory rights by use and appropriation of all of the waters of the Santa Clara River for agricultural and other purposes." By this agreement they bound themselves to abide by the decision of three referees who should "fully and finally adjust and have duly recorded" every claim to the water of Santa Clara Creek for the "present benefit and future security" of the settlers. There is nothing in the records to show the outcome of this agreement, but a similar agreement was drawn up and signed March 13, 1878. August 31, 1878, the board of arbitration appointed by the later agreement rendered a lengthy report, containing the following provisions:

(1) That the limits of the Santa Clara Creek irrigation district be extended so as to include the whole of Santa Clara Creek, the extension to be accomplished by petitioning the county court.

(2) That of this district, Pine Valley should form the first subdistrict; from the Eightmile Springs to the Warm Springs should form the second subdistrict; from Magotsa corral to the lower

[a] An act was passed by Territorial legislature and approved January 20, 1865, providing for the incorporation of irrigation companies. Under this act county courts were authorized to organize irrigation districts, upon petition of a majority of the citizens, in localities requiring more water for irrigation and in which there should be unclaimed streams that could be made to supply this need. The act provided further that after the organization of such a district the citizens of the district might organize an irrigation company to locate and construct canals and assume management and control of the irrigation works of the district, for such purpose being empowered to levy and collect taxes assessed against all the property in the district, or only the lands to be benefited. The act required that the board of trustees of the company should make annual reports of the progress and condition of the company to the county court. (Compiled Laws of Utah, 1876, Chap. III, secs. 505–528.)

end of the Truman farm should form the third subdistrict; from the upper end of Jackson farm to the lower end of Conger farm should form the fourth subdistrict; from the upper end of Fivemile Place to the head of the St. George Clara Field ditches should form the fifth subdistrict; from the head of St. George Clara West Ditch to the mouth of Santa Clara Creek, on the west side should form the sixth subdistrict; and from the head of St. George Clara East Ditch to Tonaquint Wall on the east side of Santa Clara Creek should form the seventh subdistrict.

(3) That in each of the subdistricts there should be an under water master, to be appointed by and be under the immediate supervision and control of the general water master of the district.

(4) That the first subdistrict should be entitled to water from Santa Clara Creek to irrigate 623 acres, to be divided pro rata; provided, that after notice from the general water master, all of the water of Santa Clara Creek should be allowed to flow out of Pine Valley to the settlements below for six out of each fourteen days.

(5) That William Empey should be entitled to the use of Earl Spring for irrigation.

(6) That the second subdistrict should be entitled to water pro rata with the rest of the district to irrigate 46 acres. (Individual holdings follow).

(7) That the third subdistrict should be allowed water pro rata with the rest of the district to irrigate 119 acres. (Individual holdings follow.)

(8) That the fourth subdistrict should be entitled water pro rata with the rest of the district to irrigate 40 acres. (Individual holdings follow).

(9) That the fifth subdistrict should be entitled to water pro rata with the rest of the district to irrigate 475.5 acres, provided that the citizens of Santa Clara town have sufficient water in the town ditch for household use and to irrigate the gardens in the town at low stages of water.

(10) That the sixth and seventh subdistricts should be entitled to water pro rata with the rest of the district to irrigate 800 acres.

The report of this board of arbitration was thorough and conclusive and was so accepted by the irrigators along the Santa Clara. Extending the boundaries of the district so as to include the whole creek placed the creek under the control of one authority, which was the first step in a settlement. Even before the report of the board of arbitration was rendered, namely, on January 15, 1877, a committee had been appointed to ask the county court for such an extension. October 2, 1878, it was ordered by the county court that the extension asked for be granted, and that the number of trustees be increased from 5 to 8.

The organization of the Santa Clara irrigation district has been given in detail because it has been the cause of most of the disagreement on Santa Clara Creek. For a number of years, aside from slight misunderstandings, it controlled affairs with entire satisfaction. Then doubt began to arise in the minds of the people of Gunlock and Pine Valley as to whether the affairs of the district were being administered fairly. October 14, 1880, the people of Gunlock claimed that no water was being run through the Gunlock Town Ditch for culinary and garden purposes, whereupon the directors of the district ordered that water be allowed for culinary purposes but not for garden purposes. The dissatisfaction caused by the refusal of the directors to grant water for garden purposes was increased by the directors on June 13, 1881, granting 100 inches to the settlement of Santa Clara for garden and culinary purposes, and on March 19, 1883, a petition was presented to the directors protesting against their grant to Santa Clara. The ill-feeling between the settlements continued and became aggravated as the years passed. The people of Gunlock and Pine Valley became suspicious of the water users in the lower subdistricts, and a sentiment grew that the taxes levied by the directors of the district should be resisted. Although both Gunlock and Pine Valley had representatives on the

directorate of the district, certain actions of the directors were considered arbitrary and their legality questioned. Unfortunately for the peace of the communities, some person removed from the record book of the district a number of pages covering the actions of the board from February 17, 1878, to June 15, 1879, and also from March 19, 1883, to June 8, 1888. The discovery of this fact still further aggravated the trouble, and when, on December 27, 1898, stockholders representing 675 shares in the district voted a tax of 15 cents per share on all shares in the district, ordering that if the tax was not paid by April 15, 1899, the delinquent shares be advertised and sold, the upper settlers concluded that resistance was their only course. It was decided in Pine Valley and Gunlock that the directors had no authority to levy a tax, and that as a tax it would not be paid. The settlers in Gunlock and Pine Valley were willing to bear their share of the district expenses but they split hairs over the word tax. March 25, 1899, at the meeting of the directors following that at which the delinquent shares were ordered sold, an attempt was made to disapprove the minutes of the former meeting, the division again being squarely between the representatives of the upper and the lower settlements. The drift of affairs being apparent, the sale of shares on which the tax was delinquent was postponed one month to give time for a friendly injunction suit to test the legality of the district organization. A committee of attorneys was appointed to examine the records and consult authorities. The report of the committee was to the effect that the district organization was fatally defective in that it did not give the names of the original stockholders of the district, and because the records did not show that the district had been extended so as to include the entire stream. Thereupon the sale of shares on which the tax was delinquent was postponed indefinitely.

Although the records of the county court and of the district were not sufficiently complete to stand a test of law, they were sufficiently complete to show conclusively that the district had been extended. The ordering of the extension by the county court on October 2, 1878, may not have been disclosed by the search of the attorneys, but it was, nevertheless, on the books as it is to-day,[a] and also on the books of the clerk and historian of the Mormon Church at St. George. Annual reports of the district required by the law authorizing irrigation districts[b] were filed with the county court and accepted December 31, 1879; May 1, 1880; December 5, 1881, and March 5, 1883, but, with the exception of the report for December 31, 1879, they are missing from the county files. No mention is made of the reports for the other years. The unbusinesslike manner in which the records were kept was therefore good ground for doubting the legality of the district.

After the report of the attorneys was received, opinion was divided as to whether the district should be dissolved or its organization perfected. After a year of discussion it was allowed to lapse, the last meeting of the directors being held December 15, 1900.

With the dissolution of the Santa Clara irrigation district the problem of controlling the water of Santa Clara Creek was at the same stage as when the church authorities were petitioned for a settlement, on October 3, 1875, with the exception that new complications had arisen through the gradual extension of the irrigated

[a] Book B, Minutes of the Court of Washington County, Utah. [b] See note, page 236.

areas, bringing additional reasons for determining the rights of the irrigators. Meantime, the movement toward incorporation of irrigation interests had gained ground in Utah, and to incorporate the interests along the Santa Clara was the next move. Accordingly, on August 21, 1901, the Santa Clara Field Company, comprising subdistrict 5 in the old district, and on August 22, 1902, the St. George Clara Field Company, comprising subdistricts 6 and 7 in the old district, were incorporated. During 1902, through the instrumentality of the church authorities, the interests at Gunlock were placed in like shape, and on October 15, 1902, the incorporation of the interests at Pine Valley was being effected.

LITIGATION.

One case affecting Santa Clara Creek and one case affecting its tributary, Grass Valley Creek, have been tried in the district court at St. George, and a third case affecting the rights of the entire stream is contemplated. This last case is to follow the incorporation of the irrigators interested in each of the settlements on the creek, and if the present plans of the church authorities are carried out will be brought in the United States court at Salt Lake City. The United States court is selected because the Government's interests at Shebits Indian farm, between Santa Clara and Gunlock, are affected. October 15, 1902, the advisability of the United States court's trying the case was under consideration by the United States district attorney. If the case is tried, the aim and purpose will be to finally settle every right on the stream.

*State of Utah* v. *Royal Hunt.*—The case affecting the Santa Clara was the case of the State of Utah *v.* Royal Hunt, and had reference to springs feeding Santa Clara Creek on the farm of the defendant. In the apportionment of water under the Santa Clara irrigation district regulations these springs were considered part of the creek and were subject to the control of the general district water master. During the period of controversy over the legality of the irrigation district the defendant in the suit concluded that he need not continue subject to the orders of the general water master, and they were consequently ignored and water taken from the springs at a time it had not been allotted. It occurred to the county officials that the alleged infringement on the rights of the other settlers could best be corrected through criminal proceedings against Hunt, and on August 1, 1900, the county water commissioner in water district No. 2, comprising Santa Clara Creek, swore to a complaint before the justice of the peace in St. George charging Hunt with "willfully and unlawfully turning from and using a part of the water running in the Santa Clara Creek at a time said water had been duly distributed to the people living in Santa Clara settlement for irrigating purposes, thereby changing the flow of said waters without being duly authorized to make such change." The case went to trial before the justice of the peace August 6, 1900, and on the following day the court rendered judgment finding the defendant guilty and ordering him to pay a fine of $7.50 and costs amounting to $61.05. Appeal was taken to the district court. After several continuances the case came up for trial before Judge W. M. McCarty, of the sixth district, who was invited to hear it in lieu of the presiding judge of the district. The State filed an amended complaint, alleging that the defendant, Hunt, had diverted the water of Santa Clara Creek at a time said water "had been duly and regularly distributed to the

owners thereof by Alexander Fullerton, the water master appointed by the owners of the water of Santa Clara Creek and its tributaries, thereby changing the flow of said waters without being duly authorized or having the right to make such change and use, contrary to the customs, usage, and the manner of distribution of the said waters for the past twenty years * * * and against the peace and dignity of the State." May 20, 1901, the court ordered the discharge of the defendant. The decision of the court came as a great shock to the water users prosecuting the case, who believed implicitly in the authority of the Santa Clara irrigation district over the water of Santa Clara Creek. It left no doubt whatever of the chaotic condition of water titles on the stream and showed the necessity for some speedy settlement. In his decision Judge McCarty stated that the evidence in the case did not show conclusively that the right to control the water in question had ever been surrendered to the irrigation district, and that it was questionable but that a court of equity would, on the evidence as it stood, allot to the defendant, Hunt, the stream in question. He stated, further, that the district water master had absolutely no right under the evidence to designate to the individuals within the subdistricts the amount of water they should take, that being the province of water masters of the subdistricts.

*George M. Burgess* v. *J. A. Gardner and R. J. Gardner.*—On August 12, 1899, a complaint was filed in the district court against John A. Gardner and Royal J. Gardner by George M. Burgess, alleging (1) that the plaintiff was the owner of a certain tract of land in Grass Valley and had a right to water to irrigate that land; (2) that the selectmen of Washington County, acting as water commissioners, had decided that James Rencher was entitled to a primary right to one half of the water of Rencher Canyon and that John A. Gardner was entitled to the other half; (3) that the said water commissioners had given secondary rights to the water of Grass Valley to John A. Gardner for 25 acres, to George M. Burgess for 80 acres, to H. Burgess for 37 acres, to B. Burgess for 15 acres, to R. Gardner for 5 acres, to E. Whipple for 16 acres, to R. L. Lloyd for 15 acres, and to L. Brown for 7 acres; (4) that since July 18, 1881, the plaintiff, George M. Burgess, had acquired, by purchase and appropriation, a complete title to five-sixths of the secondary rights to the water of Grass Valley, and that he had used them until the spring of 1898, when the defendants diverted the water of Rencher Canyon at different places and used it on land that had not been previously irrigated or cultivated, thus unlawfully depriving the plaintiff of his secondary rights; (5) that part of the land for which John A. Gardner had been granted a primary right by the county water commissioners was meadow adjacent to the main stream, from which the water applied in irrigation seeped back to the stream and flowed on to the land below holding a secondary right, and that the lands on which the primary rights had been used since 1898 were so situated that no water found its way back from them into the main creek. August 27, 1899, the defendants filed a demurrer to the complaint, alleging that it could not be ascertained from the complaint whether the plaintiff relied on an original appropriation, upon an award of certain alleged water commissioners, or upon a right acquired by purchase or by adverse use, and, further, that the complaint did not allege an appropriation of any water or the use of any water for any useful purpose. October 19, 1899, Judge E. V. Higgins sustained the demurrer. The decision on the demurrer covered the

ground of the complaint so thoroughly and touched on so many points of interest that the following quotation is given:

It is the contention of the plaintiff that while the defendant may ordinarily change the place of use of their water, yet where the circumstances show, as in this case, that an injury to a third party will result thereby, it can not be permitted. This is true if the injury complained of is a legal injury, such an injury as would create a cause of action against the wrongdoer. Is then the injury complained of in this case a legal injury? We think not.

It is settled beyond controversy that the owner of the soil is likewise the owner of percolating water contained in such soil, and that he assumes the same right to control it as he does the soil. If this is true then the defendants in this case would have a right to prevent entirely the escape of any percolating water within the soil owned by them from without the boundaries of such soil so owned by them and to collect and apply the same to some beneficial use. Had the defendants in this instance done this the plaintiff would not, by reason of such act on their part, have had legal cause for complaint. Allowing this seepage water to flow from their land for a long period of time, however, was no promise or guaranty on their part that they would always allow it to so flow, or that they would perpetually maintain on such tract the source of such flow, nor can such act on their part in permitting the creation and flow of seepage water be urged in estoppel of their right to use the water in such a manner that thereafter there will be no seepage.

If the plaintiff by virtue of his appropriation acquired any right it is one of definiteness and certainty. He acquired a right to have the same amount of seepage water flow correspondingly during the same season of each and every year. This means that the defendants would be held not only to use the same amount of water on the same tract each year, but further, that they must so use it that the seepage flow shall not be diminished in quantity.

It means that should any crop other than meadow require or absorb more water and thereby decrease in amount the seepage flow, the defendants would be liable to the plaintiff for whatever of damage might result to him by reason of such diminution.

A statement of these propositions shows of itself the falsity of plaintiff's contention.

Under our statute the owner of water can treat it either as personal property or as realty, and in view of this right it will hardly be claimed that the defendants in this case would not have the right to sell their water to a third person, who would equally have the right to use the same for some beneficial purpose; it might be for irrigation or for the purpose of supplying some village or city with water for domestic use. And if defendants' grantee would have this right, surely the grantor would have an equal right, for the grantor can convey no greater right than he himself possesses.

The decision on the demurrer was so clearly against the plaintiff that no further action was taken beyond filing an amended complaint.

### CLAIMS TO WATER FROM SANTA CLARA CREEK.

A number of claims to water from Santa Clara Creek have been recorded with the clerk of Washington County. These do not give any clew to the extent of appropriations, yet a summary of them is inserted below as making a part of the record of water titles on the stream.

January 2, 1896, W. L. Dykes and Joseph Lippman claimed the surplus and unappropriated water flowing in Pine Valley Narrows, and all that could be stored by dam or reservoir at that place, for irrigation in the Santa Clara Valley. January 4, 1896, the same parties filed a claim for the unappropriated water in Grass Valley Narrows, and all that could be stored at that point for irrigation in the Santa Clara Valley; and on the same day they filed another claim similar to their first one on Pine Valley Creek.

April 11, 1896, the Utah and Pacific Improvement Company claimed all the water flowing in Santa Clara Creek, about 1 mile below Foster's ranch, for irrigation on lands which are described in the notice.

August 16, 1896, A. E. Miller and George F. Whitehead claimed all the water flowing southerly from Fivemile Place, amounting to 50,000 miner's inches, for irrigation on the Santa Clara Bench and elsewhere.

A glance at the above claims will show the utter valuelessness and the failure of the law authorizing them to establish or systematize rights to water. Not a single actual appropriator of water from Santa Clara Creek appears on the list. One claim calls for 50,000 miner's inches, which is about fifty times as much water as the creek carried at its normal high flow during the spring of 1902.

AWARDS OF SANTA CLARA CREEK BY COUNTY SELECTMEN.

The county selectmen of Washington County, sitting as water commissioners, made a number of awards to the water of Santa Clara Creek. Because of the value of these records to show the date and amount of use, the following summary of them is given:

*Summary of awards of water of Santa Clara Creek and tributaries by selectmen of Washington County, Utah.*

| Date of award. | To whom awarded. | Amount of award. |
|---|---|---|
| July 18, 1881 | T. J. Jeffrey | All of Hawley and Carr springs, in Pine Valley. |
| Do | James Rencher | Primary right to one-half in Rencher Canyon and all of springs, for 60 acres. |
| Do | J. A. Gardner | Primary right to one-half in Rencher Canyon, for 60 acres. |
| Do | J. and T. H. Gardner | All in Hawley Canyon, Grass Valley. |
| Do | John A. Gardner | Secondary right for 25 acres in Grass Valley. |
| Do | George M. Burgess | Secondary right for 80 acres in Grass Valley. |
| Do | R. Gardner | Secondary right for 8 acres in Grass Valley. |
| Do | R. L. Lloyd | Secondary right for 15 acres in Grass Valley. |
| Do | H. Burgess | Secondary right for 37 acres in Grass Valley. |
| Do | B. H. Burgess | Secondary right for 15 acres in Grass Valley. |
| Do | Eli Whipple | Secondary right for 16 acres in Grass Valley. |
| Do | L. Brown | Secondary right for 7 acres in Grass Valley. |
| June 3, 1884 | Eli Whipple | Primary right to all in Pine Valley for milling purposes. |
| Do | Santa Clara irrigation district | Primary right to all of Santa Clara Creek from source to mouth. |

SUMMARY FOR SANTA CLARA CREEK.

The foregoing discussion has shown that even on a small stream such as Santa Clara Creek, if the settlement of water titles is left until all of the water becomes appropriated, instead of having each right established for all time with the first use of the water, misunderstanding and contention are sure to result. While the controversies over titles have been in progress, the difficulties of distribution have been annoying. Even with no accepted basis of division between the settlements, the general district water master continued to exercise authority so long as the district remained in existence. Soon after the lapsing of the district a water commissioner was appointed for Santa Clara Creek by the commissioners of Washington County, under the law of 1901. In the absence of a legal basis of division this commissioner has had to work more or less on sufferance and to make the divisions according to former custom and mutual agreements. Until the season of 1902 there was not a single measuring device in the creek or in any of the ditches, so that the water commissioner has been compelled to guess as to the flow of the stream and of the ditches in making the division. Acting under authority of the law of 1901, the water commissioner now in office, Mr. Brigham Jarvis, of St. George, has made an effort to have measuring flumes placed in each ditch, and has been measuring the

water in the stream and ditches over a portable Cippoletti weir with more accuracy and satisfaction than the water of Santa Clara Creek has ever before been measured.

There will be difficulties of distribution on this stream even with a definite legal basis. The loss from the stream by seepage and evaporation and the daily fluctuation in the flow are both considerable, and will have to be taken into account. Before they can be taken into account their extent will have to be ascertained by careful measurement. The flow of the creek at its source in Pine Valley; at the farms of Hunt, Foster, and Chadburn, 15 miles below; above Gunlock, and above Santa Clara settlement should be known to the water commissioner at all stages of the irrigation season if he is to divide the water justly and satisfactorily, and this flow can be obtained only with the proper measuring devices. During the spring and summer of 1902 a number of measurements were made, mostly above the Threemile Place ditches, 3 miles above Santa Clara. These measurements are given in the summary below. From the last of June to October 15 the stream carried no water below Santa Clara Town Ditch.

*Gaugings of Santa Clara Creek during 1902.*

| Date of gauging. | Place of gauging. | Discharge. |
|---|---|---|
| | | *Cu. ft. per sec.* |
| 1902. | | |
| March 8 | 200 feet above upper Threemile ditches | 9.98 |
| April 11 | do | 19.30 |
| May 8 | do | 12.37 |
| May 28 | do | 7.91 |
| June 8 | One-fourth mile above upper Pine Valley ditches | 5.25 |
| Do | Spring Branch, in Pine Valley, 100 yards below head | 2.59 |
| Do | Lower end of Pine Valley fields and above narrows | 2.61 |
| June 9 | 50 feet below junction with Magotsa Creek | 7.98 |
| Do | 200 feet above upper Threemile ditches | 4.58 |

If the move being made to adjudicate all of the rights to Santa Clara Creek in one suit, to be brought in the United States court at Salt Lake City, is successful, conditions will be greatly improved over what they are at present. It must not be expected that such a suit will be final. The time will come when there will be appropriators of the surplus flood water, and the relation of the rights to such water to those settled in the proposed suit will need to be determined. If water is ever stored on Santa Clara Creek, and it seems probable that it will be, the relation of the rights to the stored flow will need to be settled by some method not yet contemplated.

### WASHINGTON AND MIDDLETON.

The subject of water titles at Washington and Middleton has given but little concern to the irrigators in these settlements. The water in Middleton is conceded to be the property of a few farmers. August 7, 1881, Middleton Springs were granted to five appropriators by the county selectmen. Notices of appropriation are on file with the clerk of Washington County in which A. F. Macdonald, jr., claims, under date of July 13, 1897, all the water in Lime Kiln Gulch, immediately west of Middleton, amounting to 12 "inches," to be used for irrigating 25 acres; Sheridan Andrus and Henry Schlappy, jr., claim, under date of July 6, 1897, all the

water in the same gulch northwest of Middleton, amounting to 1 cubic foot per second, to be used for irrigating 20 acres; and Sheridan Andrus and Henry Schlappy, jr., claim, on August 9, 1897, the water to be obtained by tunneling three-fourths of a mile northwesterly from Middleton, amounting to 2 cubic feet per second, to be used for irrigating 20 acres. In Washington the control has been vested in the city council since the city was incorporated February 18, 1870, section 10 of the incorporating act containing the provision that "the city council shall * * * have control of the water and water courses leading to the city, provided that such control shall not be exercised to the injury of any rights already acquired by actual settlers thereon." Mill Creek, which furnishes water to the fields below town, is not under the control of the city, but instead, is under the control of the Mill Creek Water Company. Although this company is loosely organized, the interests are so small as to have caused but little friction.

### HARRISBURG AND LEEDS.

The water of Quail Creek, on which Harrisburg and Leeds are located has been used extensively for mining operations at Silver Reef, as well as for irrigation at Harrisburg and Leeds. An effort has therefore been made to keep title to the water clear, and although it has never been in court, nearly all transfers made have been recorded. June 26, 1873, the users from Quail Creek agreed to have all rights determined by a board of arbitration, and on March 4, 1874, the decision of the board of arbitration was rendered. Among the provisions of this decision were the following:

(1) When all the water of Quail Creek shall measure 120 inches or less, in the head gates, at the point of division of water between Harrisburg and Leeds, the primary claims, consisting of 162 acres, shall draw 67.5 per cent, and the secondary claims, consisting of 118.75 acres, shall draw 32.5 per cent of the water in said creek.

(2) When all the water of said creek shall measure from 120 to 150 inches, the primary and secondary claims shall draw equal shares of water per acre.

(3) All water in said creek over 150 inches shall be deemed surplus, and shall be equally divided by the water masters to *all* claims of water included in the several classes of claims as hereinafter set forth, according to the acreage of said claims.

(4) All sales of water rights hereafter shall be made by transfer and record.

This decision was satisfactory to those concerned and has been the basis for all titles since then. During the past few years there has been some disagreement over the title to the water for 18.5 acres at one time owned by the Christy Mining Company, due to a failure to record certain transactions. Although some rights at Harrisburg and Leeds are nominally primary and some secondary, all have been treated alike in distribution for some time, although assessed differently for ditch maintenance.

### CLAIMS TO WATER FROM QUAIL CREEK.

A number of claims to the water of Quail Creek and its tributary springs have been filed from time to time with the clerk of Washington County, of which the following is a summary:

May 8, 1890, Thomas P. Gillespie claimed all the water between the head of Leeds Ditch and a point in Quail Creek 4,000 feet in a northwestly direction, for mining and milling.

May 8, 1890, David McMullen and others claimed all the water of Quail Creek not used by Harrisburg and Leeds for irrigation in the Harrisburg Old Field.

January 6, 1891, James N. Louder claimed 200 inches, or all the surplus not diverted by Harrisburg and Leeds Ditch, for mining, milling, and manufacturing at the Bonanza mill site.

January 7, 1891, Thomas Judd claimed all the water of Quail Creek at the head of Leeds Ditch, for operating the Barber Mill.

January 13, 1891, M. E. Paris claimed 200 inches for mining, milling, and manufacturing at the Magdalena mining claim.

January 23, 1891, John S. Ferris claimed all the water at the junction of Cottonwood and Harrisburg creeks, for mining, milling, and manufacturing at the Ferris mill site.

January 25, 1893, August Kuhn claimed all of Grassy Spring in Grapevine Wash, near Leeds, for agriculture. January 16, 1894, the same party filed another notice, claiming the water of Grassy Spring for irrigation.

May 20, 1901, E. C. Olsen claimed all the water in Three Pine Creek, 3 miles northwest from Heath ranch, for irrigation and domestic purposes.

June 4, 1901, W. J. Custer claimed all the water in Three Pine Creek for ranch purposes.

November 25, 1901, Brundage Mining and Reduction Company claimed 500 miner's inches from Quail Creek, for mining, milling, manufacturing, and other purposes above the Leeds Dam. On January 20, 1902, the same company claimed 50 cubic feet per second for mining, milling, and domestic purposes, in the Harrisburg mining district.

### AWARDS OF QUAIL CREEK BY COUNTY SELECTMEN.

There have been a number of awards to Quail Creek and tributary springs by the county selectmen sitting as water commissioners, of which the following is a summary:

July 20, 1881, J. H. Leigh was given primary right to Leigh Springs for 24 acres.

July 20, 1881, I. S. McMullin was given primary right to springs one-half mile above McMullins field, near Leeds, for 32 acres.

August 6, 1881, Barber & Walker Silver Mining Company was given primary rights for 12 acres.

August 6, 1881, the Leeds Mining Company received a right for 14.75 acres.

August 8, 1893, W. D. Sullivan received a primary right for 8 acres, and a secondary right for 35 acres from the spring rising in Leeds field.

August 8, 1893, Hiram Leary received a certificate for primary right for 8 acres, and a secondary right for 5 acres from water rising in Leeds field.

### ON ASH AND KANARRA CREEKS.

There has been little difficulty over water titles in the settlements on Ash and Kanarra creeks. On Kanarra Creek there has been no question about the ownership of the water until recently, and on Ash Creek, while there have been a few unimportant disagreements, titles are quite well settled, although not established according to law.

### KANARRAVILLE.

For over twenty years, according to the old settlers, the water of Kanarra Creek has been used in Kanarraville and fields under an allotment made in 1881, by which the water of the creek was divided into 244½ shares by the selectmen of Kane County. During the intervening time complete harmony has prevailed in the distribution of water. In 1902, to make titles more secure, the Kanarraville Field Reservoir and Irrigation Company was incorporated and all individual rights merged into it. These individual rights were "conveyed and warranted" to the corporation in return for capital stock. No sooner had the organization been accomplished than W. T. Stapley,

one of the individual users at Kanarraville, on May 10, 1902, posted a notice at the post-office in Kanarraville claiming 5 cubic feet per second of the water of the two main springs at the head of Kanarra Creek for domestic purposes and for irrigating 160 acres of land. This notice caused consternation among the water users of Kanarraville. In making the claim it was Stapley's idea to develop the springs and take the benefit of the increased flow. It was clear to the irrigators of Kanarraville that if Stapley succeeded in making good his claim, the main supply of the newly organized company would be taken away, and they were consequently apprehensive of the outcome. Because the springs fluctuate, they believed that they would find it difficult to establish any definite flow for them. The fact of continued use of the water by the Kanarraville people seems so easy of proof that there is little apparent cause for concern. Stapley's action is but an instance of the trouble that can be caused water users if some definite basis of rights is not established and enforced before opportunity is given for complications to arise.

### HARMONY, BELLEVUE, AND TOQUERVILLE.

Because the flow of Ash Creek is so limited as to be entirely used, the three settlements on this creek, Harmony, Bellevue, and Toquerville, are independent in the matter of water titles. The springs at the headwaters are used without question by the farmers at Harmony. The basis of title at Harmony is a grant of the springs at the head of Ash Creek and of Kanarra Creek made by the county court to the old settlement on February 23, 1856, and the further award by the selectmen of Kane County of 183 shares and additional independent shares in the Harmony Springs. The settlers of Bellevue have uncontested control of South Ash Creek and of Ash Creek south of the narrows below what is known locally as the Black Ridge. This control is based on an award of water for 100 acres by the selectmen of Kane County.

At Toquerville there have been some misunderstandings over titles, due entirely to a lack of any record. December 26, 1859, it was ordered by the county court of Washington County "that the citizens of Toquerville have power and control of the waters of Ash Creek for farming, irrigation, and machinery purposes." Over twenty years later the selectmen of Kane County awarded the water of Ash Creek and Toquerville Springs to be used for 197 acres on the east side of Ash Creek, and 83.5 acres on the west side of Ash Creek, with secondary rights for 42 acres below Toquerville. These awards and continued use furnish the only basis of title the Toquerville farmers have. During recent years there has been some controversy as to what proportion of the water of the creek and springs the users on the west side of the creek are entitled to. It is claimed by some that at a meeting of the water users it was agreed that the west side should have one-third of the supply and by others that only one-fourth was voted. A lawsuit to settle the difficulty has been threatened a number of times. The only reference to the grant on the records of the Toquerville Irrigation Company is the testimony given at a meeting of all the users on May 4, 1896. At that meeting it was stated by one of the irrigators on the west side that one-third of the supply had been granted his side. The man who had been water master for many years gave equally positive testimony that only one-fourth had been granted. Two others supported the testimony of the

water master by written statements and a third testified that he had been present with the water master and a representative of the west side in 1883 when the division between the two sides was made, and that in that division one-fourth was turned into the west ditch and the remainder into the east ditch. In 1901 a committee was appointed to arbitrate the difficulty. The report of this committee was a compromise and was never agreed to by more than five or six of those interested, so that the matter is still unsettled. There is no record on the books of the Toquerville Irrigation Company of the award made by the selectmen of Kane County, sitting as water commissioners, by which the west side was given water for 83.5 acres and the east side for 197 acres. Although of no legal force, this award states the accepted division at the time it was made, which was before the controversy arose. As this award gave to the west side between the one-third and the one-fourth contended for, it is probable that it would have been accepted as the division that was once agreed to had the existence of the record been known by the parties to the controversy. That the record of the award is on the Kane County books at Kanab, 75 miles away, instead of on the Washington County records, is the probable reason for its never having been found.

### CLAIMS TO WATER FROM ASH CREEK.

A number of claims to Ash Creek and tributary springs have been filed with the clerk of Washington County. There is no evidence in the county records of appropriations having been made in accordance with the claims. The following summary gives the principal facts concerning the claims:

July 14, 1896, D. Hammond and J. Duffin claimed all of Sawyer Springs and all of Ash Creek one-half mile northwest from Kelsey's ranch, amounting to 1,500 miner's inches, for domestic and all ordinary uses, including irrigation, manufacturing, mining, and all other useful purposes, for use on lands in Washington County, described in the notice.

May 29, 1897, William H. Ivins claimed all the water in Ash Creek below New Harmony Fields except that used on Kelsey's ranch, for irrigating 160 acres of land.

August 19, 1897, William H. Ivins claimed all of Sawyer Springs for irrigating 160 acres of land.

September 30, 1897, W. A. Brinhurst claimed sufficient water to reclaim 160 acres, which is described in the notice.

### AWARDS TO WATER OF ASH AND KANARRA CREEKS BY WASHINGTON COUNTY SELECTMEN.

There were other awards made to Ash and Kanarra creeks by the county selectmen in addition to those already mentioned. A complete summary of all the awards to the creeks and tributaries is as follows:

March 8, 1891, the farmers of Toquerville received a certificate for undivided primary rights for 197 acres on the east side of Ash Creek, and secondary rights for 83.5 acres on the west side of Ash Creek, from Ash Creek and Toquerville Springs, and secondary right for 42 acres from Ash Creek, below Toquerville.

March 8, 1881, the farmers of Harmony were given a certificate of primary right to Harmony Springs for 183 acres, besides additional independent rights.

March 8, 1881, the farmers of Kanarraville were given a certificate of primary rights for 244.85 acres from Kanarra Creek.

March 8, 1881, the farmers of Bellevue were given a certificate of primary rights for 100 acres from South Ash Creek and North Ash Creek, below the narrows of Black Ridge.

August 12, 1892, A. Gregerson was given a certificate of primary right to Peter Leap Creek, flowing into North Ash Creek, 2 miles above Bellevue.

June 4, 1894, J. F. Pace received a certificate of primary rights and surplus waters at the mouth of Harmony Canyon.

### ON LA VERKIN CREEK.

The only use of La Verkin Creek is made 1 mile east of Toquerville. The watered area is small and the only difficulties over water rights have been due to enlargements of the watered area since the selectmen of Kane County in early days divided the creek into 30 shares primary right and 20 shares secondary right. One claim to water is on file for this creek, that of H. J. Jackson, filed November 5, 1898, for sufficient of the unappropriated water of the creek to irrigate the SW. ¼ of the SE. ¼ sec. 14, T. 42 S., R. 13 W.

### MISCELLANEOUS CLAIMS TO WATER IN THE CENTRAL DIVISION.

Besides the awards and claims to water in the central division of Virgin River Basin already mentioned, a number are on record which should be considered. They are given in the summary following:

October 10, 1890, the city of St. George claimed 125 miner's inches, more or less, of Cottonwood Creek, for manufacturing, irrigation, and domestic purposes.

April 15, 1896, the city of St. George claimed all the water of Cottonwood Creek 2 miles northwest from Prince's farm, amounting to 1,500 miner's inches, for domestic and all ordinary uses, including irrigation, manufacturing, mining, and other useful purposes, on lands which are described in the notice, and "any other place."

November 25, 1892, S. G. Higgins and F. R. Bentley claimed all of Goat Spring, 3 miles west of Blake & Carter's place, for ranching, grazing, and other purposes.

June 3, 1896, Alowise Baner, jr., claimed all of the water in Cottonwood Spring, on the west side of Cottonwood Bench, amounting to 8 inches, for domestic and all ordinary uses, including irrigation, mining, and other useful purposes, to be used on lands described in the notice, and "any other place."

June 9, 1896, W. and W. B. J. Carter claimed all of Carters Spring, e S. a Clara Field, amounting to 4 inches, more or less, to be used for domestic, irrigation, and other purposes, on any land.

August 10, 1896, W. Hamilton claimed all of the North Valley Springs, in Pine Valley Mountains, amounting to 3 miner's inches, for domestic, irrigation, stock, and other purposes.

August 10, 1896, M. E. Paris claimed all of the West Valley Springs, in Pine Valley Mountains, amounting to 4 miner's inches, for domestic, irrigation, stock, and other purposes.

March 27, 1899, James Andrus claimed all of Meeks Springs, for domestic and culinary purposes, at his residence in St. George.

May 10, 1901, J. L. Bunting claimed the seepage water flowing down Maple, Main, Locust, and Washington streets, in St. George, for irrigating 20 acres.

August 24, 1902, I. H. Langston and W. Reusch claimed all of Birch Creek, 3 miles northeast of Springdale, in Zion Canyon, for culinary, irrigation, and other purposes.

## THE LOWER DIVISION OF THE BASIN.

From the narrows below St. George to the junction of the Virgin River with the Colorado is the lower agricultural division of the basin. In this division are the settlements of Littlefield, on Virgin River, in Arizona; Mesquite and Bunkerville, on Virgin River, in Nevada; and St. Thomas, Overton, and Logan, on Muddy Creek, in Nevada.

### LITTLEFIELD.

Although on the banks of Virgin River, the settlement of Littlefield does not take its water from the river, but from two springs,[a] one-half mile above the settle-

[a] April 23, 1902, the south spring was discharging 3.76 cubic feet per second when the ditch was heavily grown with water grass. On the same day the north spring was discharging 1.30 cubic feet per second.

ment. Two ditches water 105 acres, in holdings averaging 21 acres, which are planted to products used exclusively in local consumption. The irrigation season extends from February 1 to October 15. There is no organization in control of the water.

Above Littlefield, on Beaverdam Creek, a small tributary of Virgin River from the north, 31 acres are farmed in three holdings; and on the river above Beaverdam Creek, 30 additional acres are watered.

### MESQUITE.

Mesquite was first settled in 1882, abandoned after two or three years, and again settled in 1894. It is on the right bank of Virgin River, 10 miles below Littlefield. The water is controlled by the Mesquite Irrigation Company, which was organized October 28, 1898, but not incorporated. The officers of the company are a secretary and a water master. The water is not distributed according to any definite plan, because the supply in the river is usually ample. Each acre draws a stream three hours each watering. The Mesquite Ditch, in Arizona, leaves the Virgin River 3½ miles above town, where a brush dam is maintained. The ditch covers 1,100 acres, all of which has been purchased from the State and will eventually be irrigated. By some alteration it can be made to cover 600 acres additional.

Above Mesquite, on Virgin River, three small ditches, aggregating 2½ miles in length, water 225 acres.

### BUNKERVILLE.

At Bunkerville, on the left bank of the Virgin River, 5 miles below Mesquite, 587 acres are irrigated in holdings averaging 18 acres. There is but one canal, which heads in the river 3 miles above town. It is 3½ miles long, 6 feet wide, and 3 feet deep. When in average condition, according to a gauging made April 22, 1902, it carries 19.62 cubic feet per second, which, distributed over the 587 acres watered, gives a duty of 1 cubic foot per second to each 30 acres. The dam at the head of the canal was first built in 1878, but has washed out fully twenty times since then, each time incurring a loss of $100 to $200. It diverts the entire river in the dry season, but much of the water seeps back to the river before reaching the Bunkerville fields.

Irrigation at Bunkerville is controlled by the Bunkerville Irrigation Company, which is not incorporated. According to the by-laws the capital stock consists of "$3 per acre," which may be increased in case additional ditches become necessary. The principal officers are a secretary and a water master. In distributing the water carried by the canal it is divided into six streams, and during the dry months of July and August each acre draws one of these streams for three hours each watering. The rest of the year no limit is placed on the amount used. Irrigation is commenced in March and continues until late fall.

Until 1900 Bunkerville was the center of cotton raising on the Virgin River, but owing to the closing of the cotton mill at St. George the growth of this product has been discontinued. The principal producing years were from 1882 to 1884. At that time the cotton goods used in the Virgin River settlements had either to be manufactured in St. George or shipped from Salt Lake City, much of the distance by team. This made the price of cotton goods high, building up the industry on the

Virgin River. In one year 47,000 pounds of lint were sent from Bunkerville to the St. George factory, returning 12½ cents per pound in trade, discounted about one-third. A test crop was planted one year by Edward Bunker, jr. Three acres yielded 2,568 pounds of lint, or over 5 bales to the 3 acres. The crop was irrigated every two weeks from April 12 to August 30. The land was choice and the culture first class. The seed planted was green seed, Pettit Gulf, and Cluster. The average yield for the settlement was only 1 bale to the acre.

The products now raised at Bunkerville are principally alfalfa, small grains, sorghum, and seedless raisins, the latter having lately become the most important. The climate at Bunkerville and adjacent settlements has been found exceedingly well adapted to the growth of the seedless grape. In 1900 one farmer took 9,000 pounds of raisins from 3 acres, which, selling at Bunkerville for 6 cents and at Salt Lake City for 7½ cents per pound, netted $450, or $150 per acre. For six years the same farmer has netted an average of $100 per acre for this product. Alfalfa produces five cuttings, averaging 6 tons to the acre, which, at the usual price, yields $36 per acre. The cuttings are made in May, June, July, August, and September. The crop is given one watering, frequently two, to the cutting. Wheat averages 27 bushels to the acre, worth 80 cents per bushel, or $23.60 per acre. Sorghum yields 100 gallons per acre, worth 35 cents per gallon, or $35 per acre.

### THE VALLEY OF MUDDY CREEK.

Muddy Creek, sometimes called Muddy River, joins Virgin River from the north 25 miles above the junction of that river with the Colorado. During flood times it receives water from Meadow Valley Wash, which extends 75 miles north of the Muddy Valley, but most of the time the source of all the water in the creek is in springs near the Moapa Indian Reservation. There is a theory held by some that these springs are fed by underground streams from Paranagut Wash, farther north and west, but no study has been made to determine if the theory is correct.

There is approximately 15,000 acres of irrigable land in Muddy Valley, almost all of which is in private ownership, having been purchased from the State. In the summer of 1902 there was approximately 2,000 acres irrigated, or 13⅓ per cent of the irrigable area. At present no attempt is made to conserve the water of the creek so as to spread it over the largest possible area. On the contrary, much is wasted. At the upper end of the valley the creek and the ditches are allowed to overflow the adjoining land until much of it is swamp. April 19, 1902, 2 miles above the head of the Saint Joe Ditch, the creek was carrying 36.78 cubic feet per second. At the point measured the bed of the creek was in a swamp, as it is for several miles above and below, and it is probable that the 36.78 cubic feet per second in the creek was considerably short of the available water in the valley. After careful observation Mr. Charles Cobb, of Overton, estimates that 1 miner's inch of water under a 6-inch pressure will irrigate 5 acres in the valley. It is probable that this estimate is too high. One miner's inch under 6-inch pressure, running continuously during the irrigation season of five months, from April 1 to September 1, would cover 2 acres to a depth of 3.72 feet, which would probably be ample. On this basis the 36.78 cubic feet per second would water approximately 3,000 acres. Below the point of measurement not more than 1,500 acres were being irrigated, or one-half of

the area that the 36.78 cubic feet per second should irrigate. When it is considered that the 36.78 cubic feet per second found in the creek April 19, 1902, was the normal flow below which the creek seldom falls, that for considerable periods the flow is larger than this, and that this measurement does not represent the amount of water which, confining the creek in a comparatively tight channel, would make available, it is clear that Muddy Valley is capable of a much larger development with only the natural flow of the creek. Add to this the reservoir possibilities, which will be discussed elsewhere in this report (see page 264), the prospects of the valley should be encouraging. Development there, however, will require a far more economical use of water and a greater adherence to approved modern agricultural methods than the farmers of the valley have yet adopted.

Several years ago an effort was made to unite the irrigation interests of the valley to make water titles more secure, and as a result the Muddy Valley Irrigation Company was incorporated in 1895, with a capital stock of $15,000, divided into 15,000 shares. It was calculated that with one share for each acre in the valley the capitalization would eventually take in the entire valley. In 1902 there were 1,514 acres of land included in the company. The company nominally controls the water of the creek and has a general water master for that purpose. In practice each settlement controls the details of distribution, with little instruction from the water master.

The settlements in Muddy Valley are all in the main valley, which is from 1 to 2½ miles wide and 15 miles long. There are but three—St. Thomas, near the mouth of the creek; Overton, and Logan, formerly St. Joseph. The principal products grown are wheat, alfalfa, and barley, with sufficient fruit for local consumption. The only sale for the products is to emigrants passing from Arizona and other southern points to the north, and in the mining and railroad camps. The upper end of the valley is on the line of the old California trail, near which the Salt Lake-Los Angeles railroads are now endeavoring to locate routes. If a railroad is built within a reasonable distance of the valley, what is now an undeveloped section should become a thriving one.

### ST. THOMAS.

There are three ditches at St. Thomas taking water from the creek, with a total length of 6 miles. From the three ditches 500 acres are irrigated in holdings averaging 50 acres. To ascertain approximately the quantity of water used per acre in the settlement, gaugings of the two main ditches were made, as follows:

*Gaugings of St. Thomas ditches, April 15, 1902.*

| | Cu. ft. per sec. |
|---|---|
| St. Thomas Town Ditch, 75 feet below head | 9.04 |
| St. Thomas East Ditch, 50 feet below head | 7.49 |
| Total | 16.53 |

When the above gaugings were made, Town Ditch was carrying its full capacity and East Ditch was carrying its usual flow. When distributed to the 400 acres under the two ditches, the water had a duty, at that stage of the season, of 1 cubic foot per second to each 25 acres.

There is no local organization in control of the water at St. Thomas, and no definite system of distribution is followed.

Formerly cotton was raised at St. Thomas, 500 pounds of lint to the acre being the average yield for the medium class soil. None has been raised for two years. It is considered a profitable crop at 8 to 10 cents per pound.

Water at St. Thomas is valued at $20 to $25 per acre. Unimproved land under ditch, with a chance to get water, can be purchased for $5 per acre. The cost of ditch maintenance is nominal.

### OVERTON.

There are six ditches at Overton, aggregating 11 miles in length, and watering 776.5 acres in holdings of 30 acres. The largest is Overton Ditch, which waters 271.5 acres. This ditch divides one-half mile above Overton into Perkins Ditch and Overton Town Ditch. April 18, 1902, Perkins Ditch, measured 50 feet below the division box, was carrying 4.05 cubic feet per second, and Town Ditch, measured 150 feet below the division box, was carrying 7.79 cubic feet per second, a total of 11.84 cubic feet per second, which, distributed over the 271.5 acres, gave a duty at that season of 1 cubic foot per second to each 23 acres. The next largest ditch is Stringtown Ditch, which waters 138 acres in the settlement of Stringtown, directly across Muddy Creek from Overton.

Although all of the ditches at Overton are subject to the Muddy Valley Irrigation Company, no uniform system of management or distribution is followed. A water master distributes water on a basis of the whole of Town Ditch to each acre under it for one hour each week, and the whole of Perkins Ditch to each acre under it for two hours each week. Regular distribution is followed from April 1 to September 1 only; at other times each user takes what water he desires at times convenient to him.

Land at Overton is valued at $2.50 to $10 per acre, the latter being comparatively choice and having some improvements. Although capitalized at $1 per acre, water usually sells for $10 per acre.

### LOGAN.

At Logan, 4 miles above Overton, five ditches, aggregating 5 miles in length, water 421 acres in holdings averaging 35 acres. The largest ditch is the St. Joe Ditch, which waters 217 acres north and east of Logan. When gauged April 17, 1902, 100 feet below the head, it was carrying 6.5 cubic feet per second, giving a duty on the 217 acres watered of 1 cubic foot per second to each 33 acres. The next largest is Logan Ranch Ditch, which waters 80 acres. April 20, when the head gate was badly choked with aquatic growth, the ditch was carrying 2.83 cubic feet per second, or 1 cubic foot per second to each 28 acres.

No regular system of distribution is followed on any of the ditches and there is no local organization in charge.

Above Logan and in the neighborhood of Moapa Indian Reservation 350 acres are watered from a number of small ditches.

### RIOVILLE.

At Rioville, where Virgin River joins the Colorado, Daniel Bonelli irrigates 100 acres from Virgin River through a ditch 1¼ miles long, which heads on the right bank of the river. During the summer months, when the flow in the river is very

low, the Bonelli Ditch takes the entire flow of the river. This flow rises a short distance above the head of the ditch.

### WATER TITLES IN THE LOWER DIVISION.

The only portion of the lower division of Virgin River Basin in which any attention whatever has been given to water titles is on Muddy Creek. At the three settlements of Littlefield, Mesquite, and Bunkerville the supply of water is considerably in excess of present needs, and water is had for the taking. Only one notice of appropriation from Virgin River in the division has been filed. The filing was made in the office of the clerk of Mohave County, at Kingman, Ariz. The claimants were Brigham Jarvis, W. J. B. Carter, and Arthur F. Miles, and the amount claimed 2,000 "inches" from Virgin River in the narrows above Littlefield "for mining, milling, and other beneficial purposes" on Paymaster mill site. The notice was filed April 5, 1902.

### MUDDY CREEK.

When Muddy Valley was first settled by the Mormon missionaries in the sixties no attention was paid to water titles. Some ditches were built in the settlements of St. Thomas, Overton, and St. Joseph, but no shortage of water was felt. With the exodus of the Mormons in 1871 and the resettlement of the valley, the first move to establish water titles was made. This was merely in the form of an official county survey on February 1 and 2, 1872, of a ditch 6 miles long. This survey was made at the instance of Daniel Bonelli, and on February 2, 1872, Bonelli filed with the clerk of Lincoln County, Nev., at Pioche, a claim for "an undivided one-fourth of a certain water ditch and 400 inches of the water running and which may run through said ditch, for agricultural purposes," and also "an undivided one-half of a certain ditch in said Muddy Valley, known as Old Farm Ditch, and one-half of the water running and which may run therein, for agricultural purposes."

This is not only the first but the only record of water rights on Muddy Creek, and the conflicting claims to the water this record refers to have furnished ground for the only contest and litigation over water rights there has been in the valley.

When the ditch referred to in the recorded survey was built, Daniel Bonelli owned a one-fourth interest, as stated in his recorded claim. For several years after the ditch was built Bonelli farmed some of the land under it, but in 1879 he moved away, whereupon his land was worked by tenants. In 1894 the interest of Daniel Bonelli in the ditch and the water it carried was turned over to his son, B. F. Bonelli. During these years the owners and their grantors of the remaining three-fourths interest in the ditch had had a slight misunderstanding with Bonelli, and also with the users of water from Muddy Creek in the upper settlements of Overton and Logan. With a view to clearing away these misunderstandings a union of all irrigation interests in the valley by incorporating the Muddy Valley Irrigation Company was proposed. A few irrigators from the creek, among them Bonelli, refused to join interests in this way, but nevertheless, on August 24, 1895, the company was incorporated. The difficulties with Bonelli were not overcome by the formation of this company, but continued to give trouble and culminated in a suit in which Bonelli was the plaintiff and the other irrigators in the valley were the defendants.

The complaint in the suit, which was entitled B. F. Bonelli *v.* T. J. Jones et al., was filed September 8, 1899, with the clerk of Lincoln County, Nev., at Pioche. Among other things it alleged (1) ownership by the plaintiff since February 12, 1872, of 400 inches, miner's measurement, of the water of Muddy Creek flowing in the St. Thomas ditches, and (2) that during and since 1896 the defendants, without right and notwithstanding the protests of the plaintiff, had diverted said water to the injury of the plaintiff. The complaint prayed for $2,000 damage and an injunction restraining the defendants from diverting the water in question. The answer of the defendants was that the plaintiff had not at any time appropriated or put to beneficial use water in excess of sufficient to irrigate 10 acres. The case went to trial November 8, 1899. Daniel Bonelli testified (1) that from 1872 to and including 1876, 57.5 acres of land had been irrigated and that 2.5 to 3 "inches" of water per acre were required for its proper irrigation; (2) that he rented his land after 1879 and could not tell what quantity of water was used; (3) that he stated to the other users from the ditch that they were using water belonging to him, but that no direct understanding was reached regarding this, and (4) that he had always claimed 400 inches or one-fourth of the ditch. B. F. Bonelli testified (1) that he took charge of the property in question as owner in 1893, and that he received a deed in 1894; (2) that in 1894 and 1896 his tenant irrigated 10 acres of vineyard requiring 25 or 30 inches of water; (3) that in 1897 20 acres were watered; (4) that in 1896 the other irrigators from the ditch objected to his having water for more than 10 acres, claiming that only 10 acres had been irrigated for a number of years, but that in reply he stated that he was entitled to 400 inches of water, and that when the water supply was reduced to 400 inches the others were using his water, and (5) that since 1896 all of the others denied his right to water for more than 10 acres. One of the defendants testified that the ditch was measured when full and in average condition and was carrying 240 miner's inches under a 6-inch pressure, and that for the five or six years last past the ditch had carried not over 75 or 80 inches during July and August.

On November 10, 1899, the court ordered that judgment be entered in favor of the plaintiff for 60 inches of water under a 6-inch pressure, which was one-fourth of the largest amount the evidence showed the ditch to have carried. December 17, 1900, the case went into court for a modification of judgment and the court ordered "that if written consent to a modification of the judgment so far as to limit and restrict the right and use of the plaintiff to 45 square inches of the water running under a 6-inch pressure between noon of the 1st day of July of each year and noon of the 1st day of February of the following year, is filed on behalf of the plaintiff within sixty days, then the motion for a new trial shall be deemed denied but otherwise shall be granted."

February 13, 1901, the written consent provided for was filed for the plaintiff on consideration that no further proceedings should be taken by the defendants. Meantime an appeal was taken to the supreme court of Nevada from the court's decision on the motion for a new trial, and on June 27, 1901, the case was returned to the lower court for retrial. In October, 1902, a new trial had not been held, and there was a probability of the difficulty being settled outside of court.

*Summary for Muddy Creek.*—The whole cause of the disagreement which culminated in this litigation was a lack of an understanding in the beginning as to the

respective rights of the builders of the original ditch. In making the survey for the ditch the county surveyor estimated that Muddy Creek was carrying 2,000 "inches," and it was on this estimate that Bonelli claimed 400 "inches" as his one-fourth share. Evidently Bonelli filed his claim to 400 "inches" in perfectly good faith with his coowners in the ditch, and in the absence of any conception of what an "inch" of water was, it was natural that he should hold to the original estimate of the county surveyor. The case is simply another instance of the confusion sure to follow leaving the establishment of titles to so valuable a commodity as water to the haphazard methods of individual appropriators having no exact knowledge of measurement and no adequate conception of the value of clear, indisputable title. Had some efficient public supervision of the appropriations from Muddy Creek been exercised when water was first used, the disputed questions would never have appeared in court. The lessons of the case should show the farmers of this division of Virgin River Basin the necessity for putting water titles into shape before there is any occasion for disagreement. The fact that nothing has yet been done toward establishing titles at the settlements of Littlefield, Mesquite, and Bunkerville is sufficient proof that there is still ample opportunity for profiting by the past experiences on the Muddy.

## THE UPPER DIVISION OF THE BASIN.

The upper agricultural division of Virgin River is principally Long Valley, on the East Fork. There are in addition several small areas irrigated on the headwaters and upper tributaries of Zion Creek, principally on North Fork. Long Valley is a narrow valley with an elevation of from 4,000 to 5,000 feet, the main section being 7 or 8 miles long. In this section are the three settlements of Mount Carmel, Orderville, and Glendale. At the head of East Fork, 12 miles from the valley proper, is Ranche.

East of Long Valley, but a few miles from the headwaters of Virgin River, flowing to the south and west, and Sevier River, flowing to the north, Kanab Creek rises and takes its way southward into the heart of the Grand Canyon of the Colorado. Since about 1870 the water of this creek has been used in irrigation, and there are to-day three settlements on its banks supported entirely from its waters. Chief of these settlements is Kanab, the county seat of Kane County, Utah, which is 4 miles north of the boundary line between Utah and Arizona. Just below the line, in Arizona, is Fredonia. At the headwaters is Upper Kanab. Although Kanab Creek is no part of the water system of Virgin Basin, it is so closely related geographically and economically to the upper division, that a brief description of irrigation in its basin is included in the discussion of irrigation in that division.

Agricultural conditions are practically the same in Mount Carmel, Orderville, and Glendale. Irrigation begins in March—sometimes as early as February—and continues until the late fall. Frosts occur until the middle of June, and are expected again by September 10. The products grown are alfalfa, wheat, oats, potatoes, and corn, with some hardy fruits and vegetables. Land with water is worth an average of $50 per acre. Water alone is held at an average of $20 per acre. In the valley there are approximately 600 acres of additional irrigable land, all of which is in private ownership. On the bench above there is an additional quarter section.

The water supply in Long Valley is limited, there being, in the opinion of many of the farmers, but about one-half enough to irrigate the land now claiming a water right. July 2, 1902, East Fork, measured 300 yards above Glendale Dam, was carrying but 7.40 cubic feet per second. The total area watered in the three settlements is 1,104 acres, or approximately 150 acres to each cubic foot per second in the stream in the middle of the irrigation season. After May 1 water seldom flows down the stream out of Long Valley to the settlements below.

### MOUNT CARMEL.

Mount Carmel is the lowest settlement in the valley. Two main ditches and one smaller one that collects the seepage water from the other two, aggregating 6 miles in length, water 422 acres. Water is distributed two and one-half hours to each acre every fourteen days. The annual assessment for ditch maintenance averages 50 cents per acre for the three ditches. The water at Mount Carmel is controlled by the Mount Carmel Irrigation Company, which was incorporated February 28, 1896, with a capital stock of $4,048.33, divided into 404.83 shares. Each share represents a water right for 1 acre of land.

### ORDERVILLE.

At Orderville there is but one ditch, which is 2.5 miles long and waters 265.5 acres. The control of the water is in the Orderville Irrigation Company which was incorporated March 3, 1896, with a capital stock of $2,980, divided into 298 shares. The ditch assessment averages 60 cents per acre per year.

### GLENDALE.

There are two ditches at Glendale—the Glendale East Ditch, 4 miles long, and watering 231 acres, and the Glendale West Ditch, 4 miles long, and watering 203 acres. Water is distributed four hours to the acre under the east ditch and three hours to the acre under the west ditch. The water is controlled by the Glendale Irrigation Company, which was incorporated March 2, 1885, with a capital stock of $4,340, divided into 434 shares, each of which represents a right to water for 1 acre. The annual assessment for ditch maintenance averages 55 cents per acre.

### RANCHE.

Above Glendale, and extending to Ranche, a series of eight small ditches irrigates 140 acres in holdings averaging 15 acres. The valley of the East Fork is very narrow and the irrigated areas much scattered. Considerable wild hay is grown, and also some alfalfa and small grain. Potatoes and hardy vegetables are the other products.

### WATER TITLES IN THE UPPER DIVISION.

Water titles in Long Valley have, after some years of confusion, become quite well settled through a decree of the district court quieting title to the whole of East Fork from Ranche to and including Mount Carmel. This decree was rendered April 18, 1900, by Judge W. M. McCarty, in the case of the Mount Carmel Irrigation Company et al. *v.* L. J. Hopkins et al. Chamberlains Lake and Lydias Fork of East

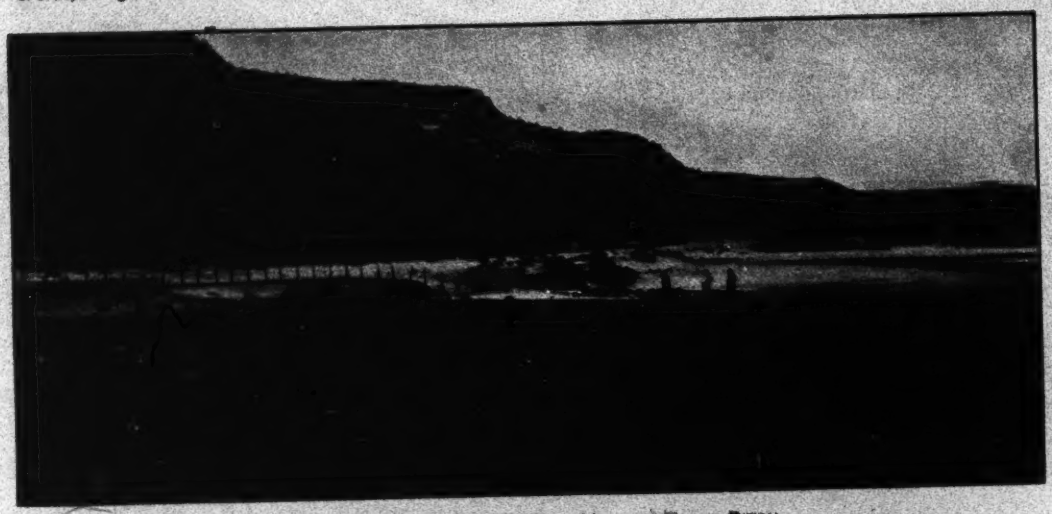

FIG. 1.—DAM IN KANAB CREEK AT HEAD OF KANAB DITCH.

FIG. 2.—ROCK LEDGE AT HEAD OF KANAB DITCH.

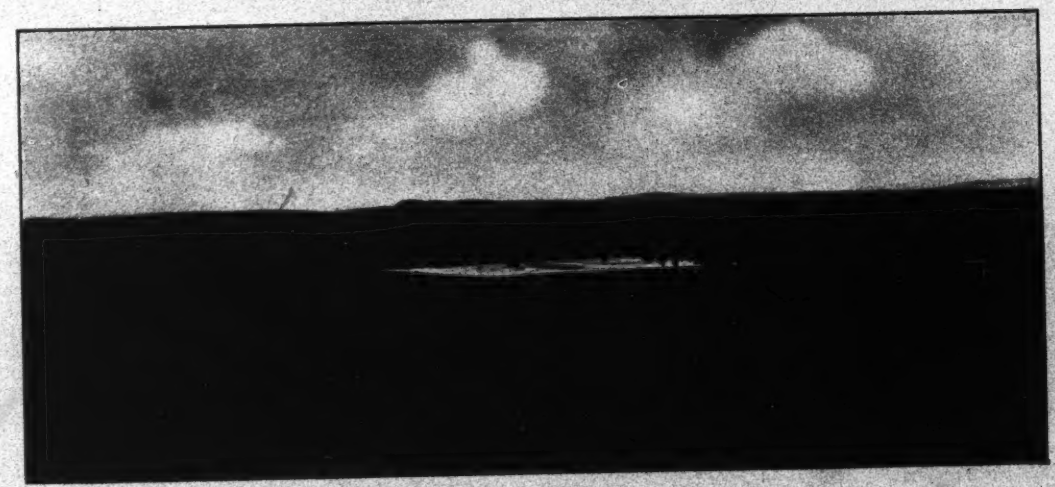

FIG. 3.—DISTRIBUTING RESERVOIR NO. 1, KANAB IRRIGATION COMPANY.

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Fork were awarded in addition to the entire stream. The main stream was divided into 1,201¼ shares, each share supposedly representing the amount of water necessary for the irrigation of 1 acre. The Mount Carmel Irrigation Company was given 404¼ shares, the Glendale Irrigation Company 434 shares, the Orderville Irrigation Company 265¼ shares, and the remainder went to a number of individuals. Each of the parties to the suit was perpetually enjoined from interfering with the rights of the others. A water commissioner was appointed by the court to carry out the provisions of the decree. There has since been appointed a county water commissioner, who exercises general supervision over the distribution of the water in the valley.

Prior to this decree, several attempts had been made to settle water titles in the valley. Conditions had been acute since settlement because of the shortage of water. March 16, 1878, articles of agreement regarding titles were drawn up by the farmers in the valley. This agreement has been lost, and its exact provisions are unknown, but whatever it was, it did not prove satisfactory, and the matter of a settlement was taken up by the Mormon Church authorities at Kanab, by whom a decision apportioning the water in question was rendered April 2, 1879. This decision stated the area entitled to water as 1,162½ acres and apportioned the water ratably over that area. Instructions were given as to the means to be employed in dividing the water. This award did not give satisfaction, and other agreements followed, which were set aside by order of court February 9, 1897, in case of G. D. MacDonald et al. *v.* Jedidiah Adair et al. The setting aside of the agreements by order of the court was the opening wedge for the adjudication of the entire East Fork in the later suit of Mount Carmel Irrigation Company et al. *v.* L. J. Hopkins et al.

### KANAB CREEK.

Kanab Creek is a small stream whose flow is comparatively constant, with the exception of summer floods. The irrigable land under it reaches many thousands of acres, and is far beyond the capacity of the creek to irrigate. Not over 1,200 acres are now watered in the three settlements of Kanab, Fredonia, and Upper Kanab, and this area can not be appreciably increased without storage. The burden of building irrigation works on Kanab Creek has been a heavy one. At Kanab alone, where no more than 750 acres is watered, $70,000 has been expended on dams and ditches. Of this amount, a large part has been expended in removing from the ditches the sand deposited by the heavy summer floods, over $700 having gone for that purpose during the summer of 1902. It is probable that this outlay would have been considered prohibitive had it been foreseen when settlement was begun. It would have discouraged the settlers had it not been that for many of them there was no choice after they had once cast their lot in this section but to face the difficulties as they were presented. The lessons of experience have therefore been hard, but the results reflect credit on the perseverance and industry of the settlers.

#### KANAB.

The only ditch taking water from the creek at Kanab, which is also the principal ditch on the stream, heads 2½ miles above town, at the Kanab Dam (Pl. XVIII, fig. 1), and follows the east bank to and past town to a small reservoir (Pl. XVIII, fig. 2).

From this reservoir two laterals are taken out, one on the west side 3 miles long, leading to the main fields, and the other on the east side one-half mile long. The head of the ditch has been cut through the sandstone banks of the canyon at the east side of the dam (Pl. XVIII, fig. 3). The construction of the dam at the head of the ditch presented difficulties similar to those encountered on Virgin River (see page 214), namely, finding a solid foundation in the sandy bottoms of the stream, and they have been likewise overcome by throwing the channel of the stream over a rock ledge. The present dam at Kanab is also the successor of numerous less substantial ones. It is 300 feet long, 64 feet high, and has a bottom width of 300 feet. The rock spillway at the east end is 20 feet wide and 200 feet long, and has been cut out of the rock bank of the canyon.

When measured on June 30, 1902, 50 feet below the head gate, Kanab Ditch was carrying 4 cubic feet per second. This was the entire flow of the creek, and was said by the owners of the ditch to be the normal flow for most of the irrigating season. This is the amount of water available for irrigating the 750 acres farmed in Kanab settlement, which is but 1 cubic foot per second for each 187.5 acres. It is also the amount of water $70,000 has been spent to control and a dam 300 feet long and 64 feet high built to divert. The right to this water is vested in the Kanab Irrigation Company, which was incorporated December 13, 1881. This company was at an early date awarded the water of Kanab Creek between Upper Kanab and the gap in the canyon below the Kanab fields by the selectmen of Kane County, sitting as water commissioners, and shares of stock in the company in proportion to their respective rights in the water as established by past usage have been issued to the individual stockholders.

Because of its extreme scarcity the water at Kanab is carefully husbanded. To avoid night irrigation two small reservoirs, one of which is shown in Pl. XVIII, fig. 3, are used for storing the night flow of the ditch. The lower reservoir, which has a capacity of approximately 60 acre-feet, is generally filled several times from the higher water in spring. The two laterals leading from the upper reservoir carry approximately 4 cubic feet per second each, that amount being considered an irrigation stream. For each share in the company one of these streams is delivered to the irrigators for four minutes each watering, and from five to seven shares are required to water each acre. Shares sell at from $8 to $9, making the cost of water from $40 to $60 per acre. The principal crop grown is alfalfa. As sufficient for local needs is not raised, the price of this product, as well as of most other products consumed at Kanab, is determined by the cost of hauling the same product from the valley of Sevier River, 100 miles north.

### UPPER KANAB AND FREDONIA.

The use of water at Upper Kanab and Fredonia is small. At Upper Kanab 127 acres are watered, the water being divided into 7 parts, 2 of which cover 50 acres, 1 covers 17 acres, 1 covers 20 acres, and 3 cover 40 acres. The title is based on the awards of the county selectmen. At Fredonia 300 acres are watered. The water there is controlled by the Consolidated Irrigation and Manufacturing Company, which was incorporated February 23, 1889, with a capital stock of $1,800, divided into "336 shares of dams, reservoirs, and ditches, together with the water of Kanab Creek" below the Fredonia Field Dam.

## WATER TRANSFERS.

With comparatively few exceptions, transfers of water in the basin of Virgin River are not recorded. Often they are accomplished by mere verbal agreements. In the incorporated companies they are entered on the books of the company at the verbal or written request of the grantor. The principal incorporated companies have not issued certificates of stock, and hence the grantee has no other evidence of title than a debit account against him on the books of the secretary for the assessments on the transferred stock. In many instances others than the original entrymen on land and the original appropriators of water are, and have been for twenty years, farming land with deed to neither land nor water; in other instances the only record of transfer is in the time book of the water master. The few exceptions to these conditions refer chiefly to the water of Quail Creek, although there are several recorded transfers to Virgin River water. More regard has been given transfers on Quail Creek because of the use made of its water for mining purposes. The deeds to water are based on the original agreement and arbitration by which the water was divided among the people of Leeds, Harrisburg, and Silver Reef. When incorporated water companies have been formed to control water formerly controlled by individuals, it is the practice for a joint deed to be executed to the company by the individual irrigators. This is not done in every case, and even when such a deed is executed it is not always recorded. These deeds lack definiteness, because in practically no case has the grantor a definite title to convey. A deed to one of the incorporated companies of Long Valley conveys "the right, title, and interest to as many acres of water right in the East Fork of Virgin River as will correspond to the number of shares set opposite" the names of the subscribers to stock in the company, but nowhere in the deed is reference made to the amount of water one acre of water right represents. The articles of agreement of the Orderville Irrigation Company contain no reference to transfers other than the number of shares of water right subscribed by each of the stockholders in the company. The deed conveying individual water rights to the Kanarraville Field Reservoir and Irrigation Company provides that the "owners and possessors of certain water rights in what is known as Kanarra Creek * * * convey and warrant to said company" all their "respective rights to the use of the waters of the said Kanarra Creek, with the number of hours or shares and the value thereof" set opposite the names of the subscribers.

Although not all entered in one book, the water transfers that are recorded in Washington County, Utah, are accessible through an abstract of real-estate transfers, water filings, adjudications of county water commissioners, water transfers, etc. This abstract shows all essential facts of record. The water transfers are segregated by streams or springs and are in chronological order. If a deed conveys both land and water, reference to the water only is made under the stream or spring to which it applies, the reference to the land being entered elsewhere.

The laws of Utah relating to the conveyance of water rights[a] contain the following provision:

> A right to the use of water appurtenant to land shall pass to the grantee of such land, and in cases where such right has been exercised in irrigating different parcels of land at different times such right

[a] Revised Statutes of Utah, 1898, par. 1281.

shall pass to the grantee of any parcel of land on which such right was exercised next preceding the time of the execution of any conveyance thereof; subject, however, in all cases, to payment by the grantee of any such conveyance of all amounts unpaid on any assessment then due upon any such right: *Provided*, That any such right to the use of water, or any part thereof, may be reserved by the grantor in any such conveyance, or may be treated as personal property, and separately conveyed.

It is this provision of the law that must, in a measure, be held to account for the incomplete records of water transfers in the basin of Virgin River. So long as water can be transferred apart from land, and the recording of water transfers is not made compulsory, so long will the records of transfer remain uncertain and incomplete. It is, of course, natural that written transfers should not always be made and recorded when the titles are as uncertain as on the Virgin River; but titles will some day be made certain, and when they are, it will be a wise step to provide for a complete and orderly record of transfers.

While it is conceded that irrigation water should, as a general rule, be appurtenant to and inseparable from the land on which it is used, there is a question whether there ought not to be some exceptions to this rule in some of the upper settlements. In Virgin City, Grafton, and Rockville considerable land that was at one time farmed under a water right equal with that of the land now farmed has been washed away by floods, leaving its owners no other alternative than taking up new land. For some of the land that washed away water certificates had been issued by the county selectmen sitting as water commissioners. Although these certificates do not carry title, they are evidence of use at the time they were issued. The question therefore arises, Have the early appropriators whose land has washed away any rights superior to those of later appropriators? This question has been asked by some of the builders of the Hurricane Canal (see page 234), and it has been proposed that the rights acquired for land that has washed away shall be transferred to the land under the new canal. While such action would be a departure from the approved principle of attaching water inseparably to land, it is at least an open question whether under the circumstances, providing no undue injury were worked the other appropriators, it would not be equitable. Reasonable diligence in making the second appropriation would need to be insisted upon if the present State laws of appropriation were enforced, but this would be a question of fact easily determinable. There seems little question that the matter should be considered when water titles are cleared up on Virgin River.

## RANGE CONDITIONS.

Of the 6,000 or 7,000 square miles in the basin, the larger portion is a public range, and from the cattle and sheep that graze on this range is derived practically the only cash income of many of the farmers. In few instances are the cattle and sheep owned by others than the irrigators of the many small farms in the basin. In 1900, according to the first annual report of the Utah State board of statistics, there were in Washington County 2,864 head of cattle assessed at $46,274, and 59,544 head of sheep assessed at $148,869; and in Kane County 2,468 head of cattle assessed at $39,595, and 28,825 head of sheep assessed at $72,062. In 1902, according to the county assessors, there were in Washington County approximately 7,000 head of cattle and 15,000 head of sheep, and in Kane County approximately 3,000 head of cattle and 40,000 head of sheep. Although these figures show a light stocking of the

range in proportion to area, the range is maintaining practically its limit because of the recent droughts. The droughts of 1894 and thereabouts were a great blow to the stock interests, many farmers being left by them with only enough stock to start a new herd. Before the drought the range between Virgin River and Kanab and in the neighborhood of Kanab supported 40,000 head of cattle and 150,000 head of sheep, but there are now not more than half that number in the entire basin. It was therefore natural that the stringent range conditions would occasion the usual rivalry between the owners of cattle and the owners of sheep. The resulting contest for control of the ranges has not ended seriously, but this control is now being effected in those localities where the farmers are most dependent upon stock by the owners of cattle purchasing or leasing from the State all of the range lands fronting on streams or containing other supplies of stock water. Much of the range has only low browse for feed, and as on such a range sheep invariably drive out cattle, the owners of cattle have been compelled in self-protection to take the steps they have. Although controlling the water of a range is an effective method of controlling the range, the agricultural interests of the basin would have been better served if the control of the water could have remained with the public, and some plan of controlling the range near the small irrigated farms in the interest of the holders of these farms worked out. Where a range is essential to the success of irrigated agriculture, as it is in some sections of Virgin Basin, there is little justice in allowing transient herds from other localities to consume the local range and curtail, as they do in some of the Virgin River settlements, the only cash income of the irrigators. The owners of both cattle and sheep in Kane County have combined to protect themselves against transient herds by purchasing practically all of the 40-acre tracts containing water in their county. The only way sheep men now have of getting into the county is by reservoiring water on the desert from the summer rains, thus obtaining a supply which will last until the winter snows.

The owners of cattle controlling the range between Kanab and Hurricane Ledge have been compelled to require that each one have in his name sufficient unfenced water to supply his stock, and as the water is greatly limited, many owners of cattle are suffering.

Besides the difficulties attending the use of the range by the cattle and sheep is the presence on the range between Kanab and Hurricane Ledge, and around Kanab, of some 5,000 head of wild horses, which the stockmen claim do more damage to the range than either cattle or sheep. These wild horses are degenerate stock of practically no commercial value, and an effort is now being made to rid the range of the trespassers by annual wild-horse drives.

## LAND CONDITIONS.

On the map of Virgin River Basin, given at the beginning of this report (Pl. XIV), are shown in different colors the areas of irrigated land and the approved individual entries and State selections. The remainder of the basin, excepting a few small areas in the mountains too small to be shown, is in State selections not yet approved, or is unentered public land. The total irrigated area in the basin is approximately 13,700 acres, the total of approved individual entries and State selections 76,000 acres, and the

total of State selections not yet approved, 14,000 acres. Outside of the barren lands and lands adapted only to grazing are large areas of fertile irrigable land. Although this land is not classified in detail by either the State or National Governments, an endeavor was made through personal examination and the assistance of Mr. Isaac C. Macfarlane, county surveyor of Washington County, Utah, who is familiar with conditions in practically the entire basin, to determine its approximate area and location. Only that land was classed as irrigable that could by any reasonable means be watered from the streams of the basin were their flow increased. Beginning with the head of Virgin River in Long Valley, and including all tributaries to the mouth of the river, these lands are classified by location and area in the following summary:

*Nonwatered irrigable lands in basin of Virgin River.*

| | Acres. |
|---|---|
| East Fork of Virgin River, in Long Valley | 800 |
| Northwest of Virgin City | 200 |
| Hurricane Bench, in addition to 2,000 acres under Hurricane Canal | 2,000 |
| Below Bench Lake on Hurricane Bench | 2,500 |
| Kanarra Creek | 4,000 |
| Ash Creek, at Harmony | 4,000 |
| Ash Creek, above Kelseys | 320 |
| Ash Creek, above Bellevue | 320 |
| Ash Creek, at Bellevue | 640 |
| Ash Creek, at Toquerville | 250 |
| La Verkin Creek | 50 |
| Quail Creek, east of Leeds and Silver Reef | 640 |
| Quail Creek, between Harrisburg and Silver Reef | 500 |
| Cottonwood Creek, near Harrisburg | 1,000 |
| Washington and Middleton | 3,500 |
| In wash below St. George and Washington Field | 1,000 |
| South and west of St. George | 1,440 |
| Santa Clara Creek, in Grass Valley | 1,000 |
| Santa Clara Creek, in Pine Valley | 100 |
| Santa Clara Creek, above Diamond Valley | 2,500 |
| Santa Clara Creek, below Gunlock | 200 |
| Santa Clara Creek, above Santa Clara | 2,500 |
| Between Bloomington and Santa Clara Creek | 200 |
| Bloomington and Price benches | 800 |
| Between lower narrows on Virgin River and Beaverdam | 2,100 |
| Mesquite | 1,500 |
| Bunkerville | 400 |
| Virgin River, between Bunkerville and Muddy Creek | 7,000 |
| Muddy Creek | 13,000 |
| Virgin River, below Muddy Creek | 7,300 |
| Total | 61,760 |

From the above summary and the figures given to show the extent to which the public lands of the basin have been entered or selected, the following generalizations are apparent: That of the 4,500,000 acres in Virgin Basin, only 1.7 per cent are in State or private ownership, only 1.7 per cent are irrigable, and only three-tenths of 1 per cent are irrigated. The question then presents itself, Is there any way for the irrigated area to be increased?

## STORAGE POSSIBILITIES.

It was not the province of this investigation to consider in detail either the storage possibilities on Virgin River or the possibilities of reclaiming an additional area of public land. Nevertheless, an endeavor was made to learn in general something of both problems, by determining the opportunities for storage that are offered in the basin.

Except at the headwaters it will probably never be practicable to store any considerable volume of water in the channel of Virgin River. This is because of the very large percentage of sediment carried in suspension by that stream. While no sediment determinations were made on the river it is probable that the percentage carried nearly equals that of some of the streams of Texas and New Mexico, and that consequently but few years would pass after the construction of a reservoir in the river channel before it would be filled by the deposited silt[a] and its usefulness ended. The formation of the watershed of the river is largely shale and sandstone, and consequently the erosion in flood times is heavy. The action of the sediment carried into the river in filling canals has already been discussed (see page 216), and it is sufficient to say here that before any reservoirs are built in the channel of the river some definite method of disposing of the deposited sediment, by sluicing or settling basins or some other means, should be worked out. At the headwaters of the river, on Big Creek, is a site for a reservoir which, if properly utilized, could be made to store a considerable quantity of water. The construction of such a reservoir has been considered as a way to insure an ample water supply under the new Hurricane Canal. In Zion Canyon, below the narrows, excellent opportunities for constructing dams are presented, but the problem of sediment would be serious there also, although probably not so serious as lower on the river.

On three of the tributaries of Virgin River reservoirs might be built that would aid greatly in obtaining a stable water supply. These tributaries are Ash Creek, Santa Clara Creek, and Muddy Creek. The possible site on Ash Creek is near Kelseys, and the water that could be stored at a reasonable expense would be of much value to the farmers of Bellevue and Toquerville. The site on Santa Clara Creek is in Pine Valley. A dam in the narrows immediately below Pine Valley settlement would spread water over a surface of 200 to 300 acres, and would impound water sufficient both to relieve the farmers already suffering for water in the lower valley of the creek and to reclaim some of the remaining irrigable land along the stream. To this site there are two main objections. One is that some of the land that would be submerged is occupied by the town of Pine Valley; the other is that the run-off from the Pine Valley Mountains above the dam would not always be sufficient to fill the reservoir when once built. During the past year practically all of the water of Santa Clara Creek has been utilized in irrigation, but still the farms have greatly suffered. Even if the lands that would be submerged in Pine Valley could be purchased, the reservoir would still have to be planned to hold sufficient water to supplement the present flow for at least two seasons. If this were not done,

[a] For a discussion of the silt problem in connection with reservoirs, see Progress Reports on Silt Determinations, by J. C. Nagle, in U. S. Dept. Agr., Office of Experiment Stations Buls. 104 and 119.

an increase in the watered area would not be justified because of the likelihood of a repetition of such dry seasons as the two past years have brought. There are two possible sites on Muddy Creek in the narrows above Logan. A dam 500 feet long and 40 feet high, 5 miles above Logan, would back the water 3 miles up the channel of the creek, and the water surface thus formed would be 80 rods wide in places. Three miles above this site is a site for a second reservoir of equal, if not greater, capacity. A reservoir on the upper site would cover several small holdings of private land, which could undoubtedly be purchased by the builders of the reservoir.

It would be of advantage to property interests and a great aid to agriculture in the basin of Virgin River if careful and detailed examination could be made of the reservoiring possibilities of the basin and some move made to build reservoirs wherever practicable. The value of small reservoirs as an insurance against drought has been clearly demonstrated elsewhere in Utah and in Colorado.[a] Before any reservoirs are built the relation of the rights to the water already used and to that to be stored should be clearly defined in order to avoid the uncertainty and confusion sure to result if this is not done.

## FINAL SUMMARY.

Because each subject dealt with in this report has been summarized as presented, a detailed and comprehensive final summary is not necessary. It is sufficient to state, in conclusion, a few general facts disclosed by the investigation.

The basin of Virgin River covers a rough area of between 6,000 and 7,000 square miles, extending over portions of Utah, Arizona, and Nevada, on which the annual rainfall is generally under 10 inches. It is watered by Virgin River and tributaries, of which Santa Clara and Muddy creeks are agriculturally the most important. With this water supply but 13,700 acres, or three-tenths of 1 per cent of the total area in the basin, is irrigated. In addition to this irrigated area, but 61,700 acres, or 1.4 per cent of the total area in the basin, could be irrigated if by some means the water sources of the basin could be increased. The possibilities for increasing the irrigated area by more careful use of water are considerable throughout almost the entire basin, but more particularly in the central division of the basin, of which St. George is the center. The possibilities for increasing the area through storage in a large way are not great, because of the heavy percentage of silt carried in Virgin River, yet the present available supply of water can be valuably increased by small supplemental reservoirs, particularly on the headwaters of the river and on Santa Clara and Muddy creeks. Nowhere in the basin are water-title conditions acute; their determination and final settlement, excepting in Long Valley, at the headwaters of East Fork, and on Santa Clara and Muddy creeks, has received no serious consideration whatever. That conditions are not acute does not mean that they are satisfactory. On the contrary, there is need for their settlement if development is to be either satisfactorily maintained or extended. The accomplishment of such a settlement presents no serious difficulties, but would readily follow a larger knowledge of the flow of the streams of the basin and an accurate knowledge

[a] See article on "Some typical reservoirs in the Rocky Mountain States," by Elwood Mead, in Yearbook of the Department of Agriculture, 1901, p. 415.

of the areas using water at the present time. For that part of the basin that is in Utah there is no reason why this information can not be gathered by the local water commissioners if they were provided with the necessary instruments and devices of measurements; yet the information would be more systematic and effective if gathered under the authority and direction of the State engineer. For that part of the basin that is in Nevada, it is clearly the duty of the State of Nevada to provide some means by which those now using water from Virgin River and from Muddy Creek can be given a definite and lasting title to the water they are using, as well as to provide some means by which in the future rights can be acquired in advance of use.

## ACKNOWLEDGMENTS.

In closing this report it is a pleasure to make acknowledgment to the people of Virgin Basin for their sympathy with the investigation and for their aid at all times. To Mr. Isaac C. Macfarlane, of St. George, for advice and aid in making water measurements, especial acknowledgment is due.

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# COURT ADJUDICATIONS OF WATER RIGHTS ON SEVIER RIVER.

By FRANK ADAMS, *Irrigation Assistant.*

## INTRODUCTION.

The Sevier River is sometimes referred to as a stream on which water titles have, through the medium of the courts, become more or less satisfactorily settled. Yet the fact that after a thorough test the present laws cause dissatisfaction among many of those most concerned, warrants grave doubt as to their being as satisfactory as their friends claim. The purpose of this study is to ascertain what has been accomplished under these laws in adjudicating the water rights of irrigators on the streams and tributaries which comprise the Sevier River system.

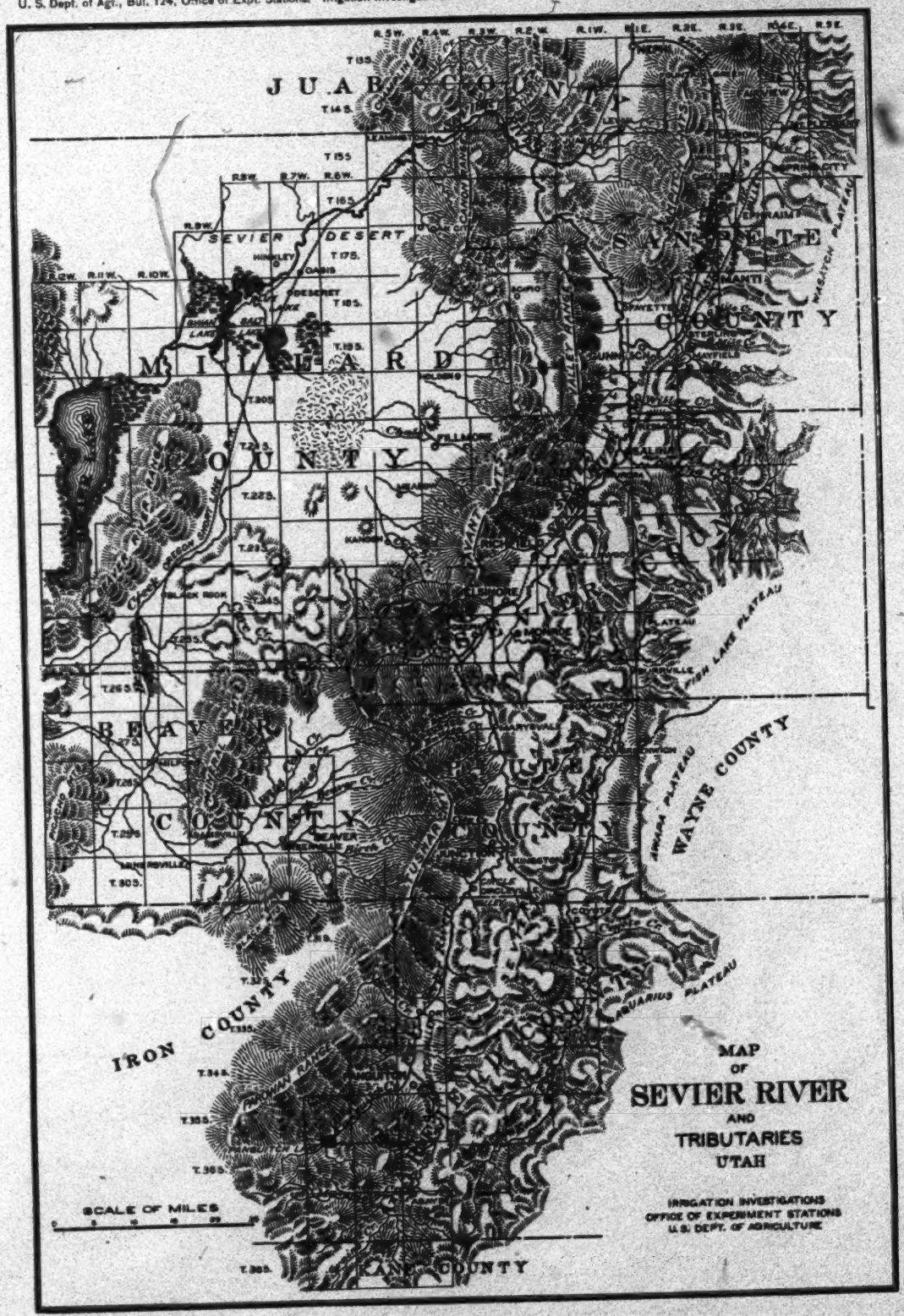
## THE SEVIER AND ITS TRIBUTARIES.

The Sevier and its tributaries form the principal water system of the central part of the southern half of Utah. (Map, Pl. XIX.) The system has an approximate drainage area of 5,500 square miles and is the chief source of agricultural productiveness for the five counties of Garfield, Piute, Sevier, Sanpete, and Millard. It covers also a portion of southeastern Juab County. The main stream, or South Fork, rises in several spurs of the Wasatch range of mountains on the northern slope of the rim of the Great Basin, in Kane and Garfield counties. It is fed in its upper end by Asays and Mammoth creeks, which meet it directly above the town of Asays, in Garfield County. Eighteen miles below, at Panguitch, it is increased by Panguitch Creek. The next principal tributary is East Fork, which joins the stream 45 miles farther down at Junction, the county seat of Piute County. On East Fork the main tributary is Otter Creek, which flows from the south some 12 miles above the junction of the East and South forks. Directly above the junction of the two main forks, joining the Sevier from the west, is City Creek, and below, in order, are the following tributaries, of which nearly all have at one time or other affected water litigation on the main stream: Tenmile Creek from the west, Manning Creek from the east, Thibidau Creek from the east, Cottonwood Creek from the west, Bullion Creek from the west, Beaver Creek from the west, Deer Creek from the west, Clear Creek from the west, Monroe Creek from the east, Cove River from the east, Cottonwood Canyon Creek from the west, Cedar Ridge Creek from the west, Kings Meadow Creek from the east, Lost Creek from the east, Salina Creek from the east, Willow Creek from the east, and Sanpitch River from the northeast. Several of these tributaries are formed from a number of branches. The river sinks in a series of lakes in Sevier Desert, in central Millard County. From the source of the South Fork to the sink is approximately 225 miles.

In its course from southern Garfield County the Sevier passes through a series of valleys separated by low ridges through which the river has cut its way, in some cases by sufficiently deep and narrow channels to make dam sites of considerable value. The principal valleys, agriculturally considered, are Panguitch Valley, with Panguitch, the county seat of Garfield County, the center; Circle Valley, around Circleville; Junction Valley, around Junction; Sevier Valley, around Richfield, the county seat of Sevier County, and Sanpete Valley, in Sanpete County. Of these valleys, the two last named are the farthest advanced. The valley of Sanpitch River is settled at intervals from Gunnison, at its lower end, to and above Mount Pleasant by a number of thriving towns, the largest of which is Manti, the county seat of Sanpete County. Below Sanpitch River ditches are taken from the Sevier throughout its course to the sink below Deseret, in Millard County. There is less agricultural land and less use of water on East Fork than on the South Fork or elsewhere on the main stream.

The characteristic slope of the valley land along the Sevier is toward the stream, and the nature of the soil is such that water diverted from the river and applied to contiguous land soon finds its way back to the river. So marked is this tendency to return seepage that it is a prime consideration in determining water titles. On the South Fork, commencing with the dam of the East Panguitch Irrigation Company in Panguitch Valley and above the junction of the East and South forks of the river, are no less than seven tight dams, each one diverting the entire flow of the river at its normal stage. At the lower end of the Sevier Valley are four more such dams. Not far below each of these dams the river carries nearly and in some instances fully as much water as it does directly above them. In one way this condition has complicated the settlement of water rights because it results in no known quantity of water to be divided, while in another way it has simplified settlement by providing a supply for ditches which without such a condition would have none. During low and normal stages of the river this return seepage has also sometimes tended to make one community independent of others below, because of the water taken out by one community affecting but little the supply of the others. This condition has resulted in several times reversing the general rule that the upper irrigators on a stream have the best water supply, a number of canals below points where large diversions are made possessing a supply which nothing less than diverting the water above to another watershed or to land remote from the channel of the river can decrease.

For some years the normal flow of the Sevier and its tributaries has all been diverted. Rights to this flow were not defined and established as acquired. The result has been that for nearly two decades the courts in the counties through which the river or its tributaries flow have been largely occupied in endeavoring to unravel the tangle. Most of the early cases with which they are concerned, and also some of the later ones, had for their object the settlement of controversies between individuals or groups of a few individuals with common interests in some small tributary or section of a stream. The more important later cases have aimed at quieting the title of all users whose rights were considered related.


JUAB COUNTY
SEVIER DESERT
SANPETE COUNTY
MILLARD COUNTY
BEAVER COUNTY
PIUTE COUNTY
WAYNE COUNTY
IRON COUNTY
KANE COUNTY
FISH LAKE PLATEAU
AWAPA PLATEAU
AQUARIUS PLATEAU
PAHVANT RANGE
MAP
OF
SEVIER RIVER
AND
TRIBUTARIES
UTAH
IRRIGATION INVESTIGATIONS
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## OUTLINE OF THE LITIGATION.

The Sevier and tributaries are diverted and used in three judicial districts, in each of which litigation over their waters has been prosecuted. From the headwaters to the line between Sevier and Sanpete counties is in the sixth district; a portion of the main stream and Sanpitch River and other tributaries are in the seventh district, and from the line between Sanpete and Juab counties about 15 miles northwest of the town of Dover to the sink in Sevier Desert the river is in the fifth district. Jurisdiction over the stream is thus divided between three courts. To obtain an account of the litigation it was necessary to search the court records in the counties of Garfield, Piute, Sevier, Sanpete, Juab, and Millard, and from the papers in 40 cases the following outline has been prepared. The cases are taken up with reference to the section of the stream or tributary they affect, beginning at the headwaters of East Fork.

### JOHN E. STEELE v. TROPIC AND EAST FORK IRRIGATION COMPANY.

In 1892 the Tropic and East Fork Irrigation Company completed a canal to divert the water in the upper end of the East Fork of Sevier River south across the rim of the Great Basin to irrigate the land which now supports the settlement of Tropic. Before the water was thus diverted to another watershed the normal flow sank, it has been alleged, a short distance below the present dam of the Tropic and East Fork Irrigation Company and before it reached the lands of the plaintiff in this action. For a number of years the settlers of Tropic used this water without interruption, but on December 4, 1896, John E. Steele brought suit to be adjudged the owner of a primary right to all of the water of the stream adversely to the Tropic people. February 9, 1897, the parties to the suit entered into a stipulation, in accordance with which a decree of court was subsequently rendered, giving to the plaintiff Steele one-half of the water of East Fork and tributaries in Garfield County from November 1 to May 15 in each year, and from May 15 to July 1 one-fourth of the natural flow, provided this one-fourth should reach down to his ditch. The remainder of the stream was given to the defendants. The users of water from this stream below the plaintiff, of whom there are a large number, were not parties to this suit, and in view of the decision rendered and the fact that the people of Tropic have been allowed to create a settlement and continue it for a number of years, it is believed by those interested that no further action against the people of Tropic will be taken.

### ISAAC RIDDLE v. WADKIN REESE, SR., ET AL.

Birch, Ranch, and Horse creeks are small tributaries of East Fork of Sevier River, in Garfield County. The decree in the case, rendered May 15, 1894, at Beaver, Beaver County, made the following awards: To the plaintiff was given "all the waters of Birch Creek and Ranch Creek, and all the waters of Horse Creek" and "one-half the waters of Horse Creek above the junction of said Birch Creek and Horse Creek, situate in Johns Valley, Garfield County," from March to November during each year, "except the surplus of the said Horse Creek above the said junction during the months of March, April, and May of each year," the surplus being "all water at the point of measurement in Horse Creek over and above the natural

flow thereof as measured on the 1st day of June of each and every year." Three of the defendants—Thomas Reese, Hiram Reese, and William Spencer—were declared "entitled to all the waters of the said Horse Creek above the said junction of Horse and Birch creeks not decreed to the plaintiffs." One Peter Larsen, "a carpenter," was appointed a commissioner to construct a proper head gate and divide the water as decreed. The defendants were ordered, wherever practicable, to construct waste ditches to carry all waste water into the channel of Horse Creek.

### HYRUM WILLIAMS v. J. S. RIDDLE ET AL.

This is an action to determine the rights of Hyrum Williams to the water of Cottonwood Creek, a small tributary of the East Fork of the Sevier, joining it in Garfield County from the west. In his complaint, filed May 19, 1902, the plaintiff alleged the use of the entire stream for the irrigation of 320 acres of land. The case had not come to trial in July, 1902.

### JAMES E. FORSHEE ET AL. v. NELS JOHNSON ET AL.

This was an action brought at Beaver, the county seat of Beaver County, before statehood. The stream in question was Otter Creek, a tributary of East Fork in Piute and Sevier counties, which enters East Fork about 12 miles above the town of Junction, in Piute County. According to the findings of the court the plaintiffs built a dam across Otter Creek in 1875 and 1876 and began diverting water for the irrigation of about 400 acres of land, taking the entire stream during June, July, and August, and continuing such use exclusively to 1878. The findings also stated that the defendants began using some of the water of the creek in 1879, each year increasing the acreage irrigated until in 1886 they diverted all of the water, to the damage of the plaintiffs; and further, that for three or four years prior to commencement of the suit the defendants had used water merely on sufferance of the plaintiffs. The conclusions of the court were (1) that the plaintiffs were the first appropriators from the stream and should have a prior right against the defendants, with an exclusive right during times of scarcity; (2) that the defendants should be required to remove all obstructions from the stream and be perpetually enjoined from diverting water from Otter Creek above the dam of the plaintiffs, and (3) that plaintiffs should have $400 damages and costs.

### KOOSHAREM IRRIGATION COMPANY ET AL v. FRANK BUSH ET AL.

This case affected the water of Otter Creek near its head. The case went to trial December 26, 1891, and a decree was rendered December 30, 1891. The plaintiffs, Koosharem Irrigation Company and 12 others, were given an undivided three-tenths of the flow of Otter Creek in Sevier County, measured at the canyon "immediately above the lands of the defendants." The remaining seven-tenths of the stream was given in definite proportion to 13 of the 16 defendants.

### E. ANDERSON ET AL v. H. McMULLIN ET AL.

The purpose of this suit was to determine the rights of plaintiffs and defendants to the water of Otter Creek. The rights of all appropriators from Otter Creek were not concerned in the suit, but only those between the headwaters and the Parker

Dam. August 18, 1899, the complaint was filed, and June 29 of the following year the decree was rendered. This gave the first 1.4 cubic feet per second to the plaintiff, the next 0.5 cubic foot per second to the defendants, and the remainder to the plaintiffs and intervener. At the request of the parties to the suit regulations for the distribution of the water were embodied in the decree and a commissioner was appointed to carry out the regulations.

### OTTER CREEK RESERVOIR COMPANY ET AL v. KOOSHAREM IRRIGATION COMPANY ET AL.

This suit sought to quiet title to Otter Creek and tributaries. It was settled by stipulation and decree of court July 18, 1901. Primary rights were given to several of the parties to the suit to the amount of 66⅔ cubic feet per second during the entire year, and 55⅓ cubic feet per second additional from April to June, besides the whole of Cedar Grove Springs and the right for the Beaver Creek Irrigation and Reservoir Company to fill its reservoir in the channel of Beaver Creek. Secondary rights were given to the extent of 90.7 cubic feet per second; third rights to the extent of 1 cubic foot per second for seventy-two hours, and 0.5 cubic foot per second for eighty-four hours, to be used at any time during March, April, and May of each year; and a fourth right to the Otter Creek Reservoir Company of the remaining water of Otter Creek and tributaries up to an amount sufficient to fill its reservoir near the mouth of Otter Creek. Head gates were ordered placed in each canal, the title of each party to the suit was quieted against every other party to the suit, and each was perpetually enjoined from interfering with the rights of the others. Jurisdiction for the purpose of appointing water commissioners to measure and distribute the water in accordance with the decree was retained by the court.

### THE LONG CANAL COMPANY AND THE EAST PANGUITCH IRRIGATION COMPANY v. PARLE HENRIE ET AL.

This was an action, in a measure friendly, to quiet title to the use of the water of Asays and Mammoth creeks, tributaries of Sevier River above the town of Asays, and of Sevier River from and above the dam of the East Panguitch Irrigation Company. A number of parties not made defendants in the original complaint were later entered as such, so as to include all users above the plaintiffs' dam. The complaint was filed August 10, 1900. November 23 of the year following, the parties to the suit agreed to a stipulation apportioning among themselves the water under contention. By this stipulation the water was to be measured in streams passing 8 inches deep over a weir dam 18 inches wide, the weirs to be constructed according to specifications in a pamphlet issued by the State engineer of Utah. A decree embodying the provisions of the stipulation was signed November 23, 1901. The decree separated the water of the stream into four classes, the second, third, and fourth classes to be subordinate to the preceding class or classes. In the first class were placed rights to the extent of 85.04 cubic feet per second; in the second class rights to the extent of 16.69 cubic feet per second; in the third class rights to the extent of 13.18 cubic feet per second; and in the fourth class rights to the extent of 9.06 cubic feet per second. It was the intention, when separating the rights into four classes, that the first or primary right of 85.04 cubic feet per second should embrace

the normal discharge of the stream, but in case the stream fell below that, or in case there should not be sufficient water to supply the awards in any one or all of the three other classes, then the water was to be distributed pro rata among the users in the class in which there was a deficiency. This was a wise provision in the decree, because on July 5, 1902, Asays and Mammoth creeks, which on that date were furnishing the sole supply, were carrying together but 53.47 cubic feet per second.[a] The court ordered all persons to whom water was awarded by the decree to construct, under the supervision of the court water commissioner, weir dams for measuring their portion, and retained jurisdiction of the case for the purpose of annually appointing a water commissioner to carry out the provision of the decree.

### CIRCLEVILLE IRRIGATION COMPANY ET AL. v. ORSON DALTON ET AL.

This was an action to establish the rights of the Circleville Irrigation Company, the Lost Creek Irrigation Company, and certain individuals to the water of Sevier River. The complaint was filed May 17, 1899, and on October 31, 1899, a settlement was stipulated and the same day embodied in a decree signed by the court. This decree awarded to the corporations and individuals concerned all the water of Sevier River between the head of the Maximillian Parker Ditch and the head of the J. Whittaker Ditch. The awards were in both cubic feet per second and in fractional parts of the stream. Three individuals and two corporations received water by the decree. Suitable measuring devices were ordered placed, under the supervision of a court water commissioner, at the head of each ditch. For the future regulation and economical distribution of the water decreed the court retained jurisdiction.

### JUNCTION IRRIGATION COMPANY v. R. D. L. MITCHELL.

This was an action seeking to restrain the defendant from diverting the water of springs discharging into the canal of the Junction Irrigation Company a short distance from the town of Circleville, in Piute County. July 8, 1899, the complaint was filed. July 18, 1899, a temporary restraining order against the defendant diverting the water in question was issued by the court. November 1, 1899, the court appointed a commissioner to measure the canal of the Junction Irrigation Company. November 2, 1899, the Junction Irrigation Company was awarded the capacity of the canal, and the defendant was given a small stream. The court commissioner, owing to loss of field notes, has never rendered a report on the capacity of the canal, so that a decree stating the award to the Junction Irrigation Company in definite quantity has never been rendered.

### E. A. ANDERSON v. W. H. McINTOSH ET AL.

This was a suit to determine the rights of plaintiff and a number of defendants to the water of City Creek, a tributary of the South Fork of Sevier River, entering it from the west a short distance below Junction settlement. The complaint was filed November 21, 1898, and a decree rendered June 7, 1899, apportioning the entire stream among the parties to the suit. Two of the defendants were given, for

[a] On July 5, 1902, the discharge of Asays Creek, measured 2 miles above the mouth of Mammoth Creek, was 36.12 cubic feet per second, and of Mammoth Creek, measured 1 mile above its junction with Asays Creek, was 17.36 cubic feet per second.

culinary and domestic purposes, in addition to three-twelfths of the stream, a stream of water "continuously flowing through an aperture 1½ inches high by 2 inches wide, to be maintained in the extreme lower southeast corner of the dividing box now used * * * for their three-twelfths of said water, the weight of pressure for the said culinary and domestic stream to be determined by the said entire three-twelfths of the waters of said City Creek passing through the said dividing box in the same manner as it does now."

### D. C. THOMPSON v. MARINER SMITH ET AL.

The stream in question in this suit was Thibidau Creek, a small tributary of Sevier River, entering from the east a short distance below Junction, in Piute County. The decree rendered May 11, 1893, at Beaver, Beaver County, gave to the plaintiff the entire flow of the stream throughout the year, except at such times as it should carry water in excess of the amount necessary to fill plaintiff's ditch, when defendants were entitled to such surplus. Each party was perpetually enjoined from interfering with the rights of the others.

### ANDREW J. SARGENT AND H. E. LISONBEE v. HENRY NELSON ET AL.

This case was tried at Beaver, Beaver County, before statehood, beginning November 9, 1895. By the decree the water of Manning Creek, a tributary of Sevier River below the junction of the east and south forks, flowing from the east, was divided between plaintiff, Andrew J. Sargent, and defendants, Henry and Lizzie Nelson. Sargent was given the whole of the stream, up to the capacity of his ditch, during the period of high water from April 15 to July 1 of each year, and all of the water during low water from July 1 to November 1, excepting every twelfth day, when the whole stream should go to the defendants, Henry and Lizzie Nelson. These defendants were also given a second right to the stream during high water, to the capacity of their ditch, with a further allotment during low water, to supply domestic and stock needs, not to exceed "one-half cubic-inch flow under a 2-inch pressure."

### H. E. LISONBEE ET AL. v. JOHN DENNIS ET AL.

This was an action to determine the rights of the plaintiffs to the water of Cottonwood Creek, a tributary entering Sevier River from the west below Thibidau Creek and above Bullion Creek, in Piute County. June 21, 1898, the complaint was filed. March 29, 1899, a compromise was effected and accepted and a decree rendered apportioning the water of the creek between the plaintiffs and defendants. The decree did not "in any way affect or determine" the rights between themselves and the other plaintiffs or certain of the plaintiffs. A court commissioner was appointed to measure the water and distribute it in accordance with the decree.

### JOSEPH CHESSELLE v. JOSEPH HOWES ET AL.

The decree in this case was rendered at Beaver, Beaver County, September 18, 1893. By it the plaintiff, Joseph Chesselle, was declared to be the owner by prior appropriation of the right to the use and control of one-third of the water of Tenmile Creek, a tributary entering Sevier River from the west below Junction, Piute

County. By stipulation of the parties the plaintiff was to use the one-third of the stream only from October 15 to June 14 of each year, and the whole of the stream three days out of nine the rest of the year. The remaining use of the stream was awarded to the defendants. Each party was perpetually enjoined from interfering with the rights of the others.

### MARTHA H. PITTS v. J. CHESSELLE ET AL.

This was an action to settle the rights of the plaintiffs and defendants to the water of Tenmile Creek. The suit was not intended to settle the rights of all appropriators from the stream. September 3, 1897, the complaint was filed, and March 19, 1898, judgment was rendered by the court, giving the whole stream to the plaintiffs the first sixteen hours out of every one hundred hours and to the defendants the next seventy hours out of every one hundred hours. Suitable devices for the measurement of the stream were ordered placed in the stream.

### MONROE TOWN v. ANDREAS BERTELSEN ET AL.

This case was intended to determine the rights of the town of Monroe, Sevier County, and a number of individuals to the water of Monroe Creek, a stream rising in the mountains east of Monroe and flowing in a westerly direction past that town to the Sevier. The case went to trial March 17, 1898, and a decree was rendered March 19, 1898. By this decree primary rights and three classes of secondary rights, besides an independent right of the whole stream, to the defendant, Andreas Bertelsen, for milling purposes, subject to rights for irrigation, were issued. The basis for the award of the primary and first two classes of secondary rights was a duty of water of 1 cubic foot per second for each 60 acres of land irrigated. To the residents of the town of Monroe was given 7.2 cubic feet per second and to defendant, Andreas Bertelsen, 0.1 cubic foot per second primary right; to Monroe town and certain defendants was given $4\frac{4}{7}$ cubic feet per second secondary right, class 1, and to other defendants $15\frac{1}{7}$ cubic feet per second secondary right, class 2. It was provided that in case there was not enough water to supply any particular class according to the apportionment, the available supply should be divided ratably. To the defendant, Andreas Bertelsen, was also given a third-class secondary right of 11 cubic feet per second, to be diverted through a ditch at that time under construction. Head gates were ordered placed at such points on the creek as were adapted to facilitate the division provided in the decree, and a commissioner was appointed to make such division.

January 21, 1899, upon the agreement of the parties to the suit, the decree was amended by the court, making the duty of water for the primary rights 1 cubic foot per second for each 50 acres of land irrigated and increasing the primary rights awarded to 8.7 cubic feet per second; also the area irrigated under secondary rights, class 1, was increased to 346 acres and the award of water to $5\frac{1}{7}$ cubic feet per second.

### MILES DURKEE v. JOSEPH BROWN ET AL.

This was originally an action to settle the right of the plaintiff to the water of Bullion Creek, a tributary of Sevier River, entering it from the west at Marysvale, Piute County. The original suit was entitled "Miles Durkee *v.* Orson Lee et al." The complaint was filed May 11, 1896, and on the same day, by stipulation of plaintiff

and defendants, a referee was appointed by the court to take testimony and finally determine the rights of the respective parties to the suit. The appointment of the referee was objected to by several of the defendants on the ground that the Compiled Laws of Utah of 1888, Volume II, chapter 2, section 2775, provided otherwise for determining rights in relation to water. July 3, 1896, the referee filed his report, stating the amount of water awarded to each party concerned, as based on the testimony taken. Two weeks later, on July 15, the findings and report of the referee were set aside by the court and an agreement signed by some of the litigants making 35 parties plaintiffs in another suit. For over a year the case dragged on, with a stream of amended complaints, cross complaints, answers, demurrers, amended cross complaints, and complaints in intervention, numbering over 100, pouring into the office of the court. November 27, 1897, the attorneys, of whom there were now ten, began stipulating without reference to the rights of certain parties not represented in court by attorneys. At this juncture the court took occasion to warn the attorneys that all parties to the action would have to be represented in the decree before his signature would be attached, and that he did not propose to have the rights of unrepresented parties stipulated away by the attorneys "simply because some of them have refused to hire an attorney and pay out four or five times what their water is worth in order to employ them."

A provisional decree was rendered embodying the final stipulations in court. This decree provided that Bullion Creek have four stages of water—normal water, and first, second, and third stages of high water. The normal flow was distributed to the owners of 341 acres, the first stage of high water to the owners of 117 acres, the second stage of high water to the owners of 192 acres, and the third stage of high water to the owners of 403 acres. Each of the parties to the suit was perpetually enjoined from interfering with the water belonging to the others, and also from changing his point of diversion without the written consent of all parties affected by such change.

The decree was provisional in this: No evidence introduced in the trial was conclusive to the court as to the volume of water carried by Bullion Creek at its different decreed stages, or as to the duty of water on the stream. The court therefore retained jurisdiction and appointed a commissioner to ascertain this information through measurement and study, which in his opinion was essential to final decree. Pending the results of the commissioner's measurements and study, the court retained authority to "make such temporary provisional orders for the distribution of the stream as may seem to it meet and proper, or necessary." One such order was made by the court May 10, 1898, providing that the water of Bullion Creek be allotted on a basis of a duty of 1 cubic foot per second to each 70 acres. A final decree has not yet been rendered.

### RICHFIELD IRRIGATION CANAL COMPANY v. ANNABELLA IRRIGATION CANAL COMPANY ET AL.

This was an action to determine and establish the rights of all users of water from Sevier River from the town of Joseph, in the upper end of the valley, to the Vermilion Dam, in the lower end of the valley. Eight water companies and 24 individuals were concerned in the suit. The complaint was filed April 23, 1896. A decree by stipulation was rendered October 23, 1897. Because of neglect on the part

of some of those concerned in paying the court fees the decree has never been recorded.

The decree apportioned the water of Sevier River among the litigants whenever it should become reduced to an amount not exceeding 101 "feet" measured at the various head gates and above what is known as the Nilsson Dam, as follows:

| | Per cent. |
|---|---|
| Richfield Irrigation Canal Company | 35.5 |
| Joseph Irrigation Company | 10.0 |
| Isaacson Ditch | 1.5 |
| Wells Irrigation Canal Company | 4.5 |
| Monroe Irrigation Company | 19.0 |
| Elsinore Canal Company | 7.0 |
| Brooklyn Canal Company | 11.5 |
| Annabella Irrigation Canal Company | 8.5 |
| Nilsson Ditch | 2.9 |
| Higgins Ditch | .5 |

The Vermilion Irrigation Company was given the seepage between Nilsson Dam and Vermillion Dam and from Richfield fields north of Vermilion Dam.

It provided that the measurement should be made "by multiplying the width of the water of said canals by the depth of water flowing therein," and further provided for a commission representing all interests in the suit to distribute the water of the river according to the rights decreed. The commission was instructed to place weirs in the head gates of each ditch prior to the commencement of the irrigation season of 1898.

### RICHFIELD IRRIGATION CANAL COMPANY ET AL. v. CLEAR CREEK IRRIGATION COMPANY ET AL.

This was a suit to quiet title to the rights to Sevier River and tributaries from the Vermilion Dam, in Sevier Valley, Sevier County, to the headwaters of the East Fork of the Sevier River, in Garfield County. The complaint was filed June 29, 1899, and the decree rendered January 14, 1901. As either plaintiffs or defendants, most, but not all, of the parties taking water or claiming a right to take it from the Sevier or its tributaries between the points mentioned were parties to the suit.

This was the most extensive suit that has been brought affecting the water of the Sevier River, and the decree rendered, despite some conflicts, was one of the most satisfactory of the various ones handed down. Twelve incorporated canal companies and nearly 150 individuals were awarded water by the decree. It took into consideration, as well as it could under the circumstances, both the area of land irrigated and the duty of water. As to the former, its ruling was based principally on the testimony of witnesses and plats and diagrams submitted by the plaintiffs; as to the latter, on the testimony of witnesses, but principally on the report of a civil engineer employed by the plaintiffs to make a personal examination and analysis of the soil in different sections of the valleys concerned in the suit.[a] The purpose of this suit was to obtain a decree as between the plaintiffs as a whole and

[a] This engineer reported that 1 cubic foot of water per second would irrigate from 50 to 80 acres in the Sevier Valley, from 40 to 125 acres on Beaver Creek, from 60 to 65 acres on Bullion Creek, from 65 to 120 acres on Cottonwood Creek, from 80 to 100 acres on Coyote Creek, and from 50 to 85 acres elsewhere on the stream.

the defendants individually. The defendants met this move with a counter play, joining interests for defense. As thus joined, the plaintiffs among themselves and the defendants among themselves had conflicting interests, and a decree dividing the water under contention between plaintiffs and defendants as between individuals would have but opened the way for numberless future suits between the individuals and corporations composing the plaintiffs, as well as between the individuals and corporations composing the defendants. To forestall such a disaster the presiding judge, in his decree, instead of awarding a certain portion of the river to the plaintiffs collectively and the remainder to the defendants collectively, determined separately the rights of each individual and corporation. By the decree rights to the water of the river and its tributaries to the extent of 364.83 cubic feet per second were made primary. Subject to these primary rights, a secondary right of 68 cubic feet per second was given to the Sevier Valley Canal Company, and a third right of 47 cubic feet per second to the Monroe South Bend Canal Company and others. A "fourth right to the use of the waters of Bullion Creek"[a] to the extent of 7.1 cubic feet per second was awarded to 23 users, and Tenmile Creek and East Fork at the dam of the Kingston Irrigation Company were awarded in whole or in fractional parts as primary rights. Beaver Creek, when reduced to 6 cubic feet per second, was awarded to four users.

In determining primary rights the court did not consider evidence of use farther back than seven years, following the old statutory provision that seven years uninterrupted beneficial use of water establishes a primary right.[b] He therefore awarded a primary right to all parties whom he found to have used water uninterruptedly "for more than seven years last past."

Following the enumeration of primary rights, the decree provides that in case there should be insufficient water in the river and its tributaries to satisfy the primary rights, the water available should be divided ratably. A similar provision follows the decree of third rights on the main stream and "fourth" rights on Bullion Creek. Measuring gates or weirs were ordered placed at the head of each canal or ditch, the title of each party quieted, and each party was perpetually enjoined from interfering with the rights of any of the others. The court retained jurisdiction in the case for the purpose of enforcing the decree and appointing water commissioners from time to time to supervise the construction and maintenance of head gates and to distribute the water in accordance with the decree.

### RICHFIELD IRRIGATION CANAL COMPANY ET AL. v. CIRCLEVILLE IRRIGATION COMPANY ET AL.

The complaint in this suit was filed August 14, 1902, but the case will likely not go to trial for several months. It will be one of the two most far-reaching cases of water litigation yet tried in southern Utah, the other being the case of Richfield Irrigation Company et al. *v.* Clear Creek Irrigation Company et al., decided January

[a] Although the language of the decree is as quoted, it is probable that the decree is intended to give a "fourth" right to the water of Sevier River and its tributaries, to be taken from Bullion Creek.

[b] Compiled Laws of Utah, 1888, section 2780, provides that "whenever any person or persons shall have had the open, peaceable, uninterrupted, and continuous use of water for a period of seven years" a primary right to that water will have accrued.

14, 1901, discussed above. Six canal companies appear as plaintiffs and 13 canal companies and 145 individuals as defendants. These plaintiffs and defendants supposedly comprise every water user or water claimant from Sevier River or its tributaries, excepting Bullion Creek and one or two minor tributaries, between the dam of Vermilion Irrigation Company, in the lower Sevier Valley, and the headwaters of the South Fork of Sevier River, in Garfield County, a distance of approximately 150 miles.

The allegations made by the plaintiffs in their complaint amount to a claim of exclusive right by the plaintiffs and certain of the defendants of the "right to manage, control and regulate, divert and use portions of the waters of the Sevier River and its tributaries," this claim being based on an alleged diversion in Sevier County in 1878 by the plaintiffs or their grantors of "all the waters of said river therein flowing from every source whatsoever above the point * * * where the Vermilion Dam is located * * * up to the headwaters of the South Fork of said river, * * * including all the waters which flow into said river from the tributaries as aforesaid, * * * being about 300 cubic feet of water per second of time, * * * being at the time unappropriated water of said river and the whole supply thereof." Five canal companies and 19 individuals who are made defendants are acknowledged in the complaint to be united in interest with the plaintiffs in the subject-matter of the action, but they are made defendants because of their unwillingness to become plaintiffs. The prayer of the complaint is that the defendants "be required to set forth the nature of their claims to the right to the use of said waters, and that all adverse claims of said defendants to the use of the said waters be determined by decree of the court, and that plaintiffs have judgment quieting them in the use, right to the use, and title of all of said waters against the defendants and all and either of them, and that said defendants have no right or title to the same, or any portion thereof."

### LOST CREEK IRRIGATION COMPANY.

This company was concerned in a suit affecting Lost Creek, a tributary of Sevier River in Sevier County, tried at Provo before statehood. A search in the records at Provo failed to produce the papers in the case. The exact title of the case was unknown by any of the officers or attorneys consulted.

### WILL COOK ET AL. v. LOST CREEK IRRIGATION COMPANY.

This was an action in which the plaintiffs prayed to be decreed the owners of 2 cubic feet per second and "210 cubic inches of water measured under a 4-inch pressure" from Lost Creek, a tributary of Sevier River, from the east below the canal of the Willow Bend Irrigation Company, in Sevier County. The plaintiffs claimed to have increased the flow of certain springs feeding Lost Creek. The complaint was filed January 30, 1898, and a decree rendered August 15, 1898. Before rendering the decree the trial judge personally examined the springs claimed to have been increased, and he also appointed a court commissioner to measure them. The court, from his examination, the report of the court commissioner, and the evidence, found that no such increase in the springs as was alleged by the plaintiffs had been effected, and in the decree dismissed the action and ordered the plaintiffs to take nothing by

it. He confirmed the right of the defendant company to 25 cubic feet of water per second from Lost Creek, and ordered the plaintiffs to construct a weir in the channel of the river for the measurement of the defendant company's 25 cubic feet per second, under a penalty, for failure to construct such weir, of being "at no time entitled to use or divert from the natural channel any portion whatever of the waters of Lost Creek." The defendant was also given judgment against the plaintiff for $208 costs. From the language of the court it is evident that in his opinion the plaintiffs had attempted, by force of expert testimony, to secure title to water clearly the property of others.

### REX v. LOST CREEK IRRIGATION COMPANY.

This suit affects the water of Lost Creek, a tributary of Sevier River entering it from the east, in Sevier County. The case was tried in the district court at Richfield, and is now on appeal to the supreme court of the State, the appeal being taken principally on the ground that the decree of the lower court did not sufficiently take into account the duty of the water or the area irrigated.

### SALINA CREEK IRRIGATION COMPANY v. SALINA STOCK COMPANY.

In this case the plaintiff claimed all of the water of Salina Creek, fed by Yogo and Neoche creeks, for farming and culinary purposes, based on an alleged twenty years' use. The further allegation was made that during the six years prior to commencement of the suit this use had been interrupted by the defendants. The decree of the district court was in favor of the plaintiff, although it reserved undefined rights to the defendants. An appeal to the supreme court was taken by the defendants on several grounds, among them that the decree was so uncertain that by it the rights of neither party could be ascertained. From its review of the evidence the supreme court was satisfied that the appellant, Salina Stock Company, was entitled to more water than was allotted to it by the lower court, and an order was made for the decree to be so modified as to give the respondent, Salina Creek Irrigation Company, the use of all the water of Yogo and Neoche creeks from June 15 to November 1 of each year, except during the whole of Monday of each week during that period, when appellant should have one-half of Yogo Creek, and during the whole of Friday of each week in that period, when appellant should have one-half of Neoche Creek, with a continuous right during the period to stock and culinary water. From November 1 to June 15 of each year the respondent was given the use of such water of the two creeks as it might need, not exceeding one-half of the total flow. Sufficient to supply its needs up to the remaining one-half of the total supply was also given to appellant, Salina Stock Company. Each party was ordered enjoined from interfering with the rights of the other.

### WILLOW CREEK IRRIGATION COMPANY ET AL. v. SARAH C. MICHAELSON.

This was an action in which the Willow Creek Irrigation Company sought to enjoin the defendant from diverting the water from certain springs rising on her land which for several years had flowed into Willow Creek and had been used by the plaintiffs. The point at issue was whether the springs in question were subject to appropriation under the State law. The land in which the springs rose was conveyed

by the United States Government to the defendant, Sarah C. Michaelson, in 1891. Subsequent to this conveyance water appeared on the land from natural causes, first as a marsh and then, in 1895, as a stream flowing into Willow Creek. After reaching Willow Creek the water from the spring was used with the other water of this creek by the plaintiffs. In 1898 and 1899 the defendant diverted the water, thereby preventing its flowing into Willow Creek, whereupon suit was commenced by the plaintiffs to prevent this diversion. The trial court rendered judgment in favor of the defendant, holding that the water was a part of the land conveyed by the Government to the defendant, and hence not subject to appropriation. The plaintiffs appealed to the supreme court, which on March 30 sustained the judgment of the lower court (21 Utah, 248).

In their argument before the court the appellants claimed that the water in question was a natural stream, and hence subject to appropriation under section 2780, Compiled Laws of Utah, 1888.[a] The court maintained that the "natural stream or other natural source of supply" of the law must be construed to mean one "flowing or situated upon lands over which the sovereignty has domain, or which forms a part of the public domain, and not to streams, or springs, or other waters rising through percolation upon land after it has been segregated from the public domain and the title thereto passed into private ownership." "A conveyance or grant by the United States," continued the court, "of any part of the public domain * * * carries with it the right of filtrating or percolating water, and to streams flowing through the soil beneath the surface, but in undefined and unknown channels, just the same as it carries with it the right to rocks and minerals in the ground which have not been reserved in the instrument of conveyance or by statute. * * * In the eye of the law water so commingling and flowing, or motionless, underneath the surface, is not the subject of ownership apart and distinct from the soil."

### BIRCH CREEK IRRIGATION COMPANY ET AL. v. DELBERT TERRY ET AL.

This action sought to establish the plaintiffs' rights and to determine the defendants' rights to Birch Creek, a small stream entering San Pitch River between Fairview and Mount Pleasant, in Sanpete County. The complaint was filed June 7, 1900. August 16 and 30, 1901, several parties claiming rights to Birch Creek entered voluntary appearance, claiming such action to be "necessary for a full adjudication, settlement, and quieting of title to the water of Birch Creek." October 5, 1901, the water in controversy was divided by stipulation, embodied the same day in a decree of court, among the plaintiffs, defendants, and those who had entered voluntary appearance. By the stipulation it was agreed that 1 cubic foot of water per second should water 80 acres; that when Birch Creek should carry more than 28.06 cubic feet per second it should belong equally as a primary right to Birch Creek Irrigation Company and others; that when the creek should carry water in excess of the primary

[a] A right to the use of water for any useful purpose, such as for domestic purposes, irrigating lands, propelling machinery, washing and sluicing ores, and other like purposes, is hereby recognized and acknowledged to have vested and accrued, as a primary right, to the extent of and reasonable necessity for such use thereof, under any of the following circumstances:

First. Whenever any person or persons shall have taken, diverted, and used any of the unappropriated water of any natural stream, water course, lake, or spring, or other natural source of supply.

rights one-half of the remainder up to 16.5 cubic feet per second should go to water users on the north side of Birch Creek, to be controlled by the Birch Creek Irrigation Company, and the remainder up to 16.94 cubic feet per second to the users on the east side of the creek, to be distributed by the Mount Pleasant and Birch Creek Irrigation Company. The decree also affirmed and quieted the title of the parties to the suit to the water of Birch Creek and enjoined each from interfering with the rights of others.

### CHESTER RESERVOIR DITCH COMPANY v. SPRING CITY ET AL.

The purpose of this suit was to quiet title to the water of Canal and Oak creeks, which, united, flow into Sanpitch River below the town of Chester, in Sanpete County. October 15, 1897, the complaint was filed. May 11, 1898, the court issued an order entering in the suit other water users from Oak and Canal creeks, the purpose being to settle at one time the rights of all parties interested. May 18, 1899, the plaintiffs and defendants entered into a stipulation dividing the water of the creeks into 10 classes, each subordinate to the preceding class, and awarding to each class and to each individual within the classes a definite number of miner's inches. Dividing the available supply in any class ratably when the water in the creeks should not furnish enough to satisfy the awards in that class was ordered by the decree, and a court commissioner was appointed to measure and distribute the water in accordance with the decree. The title of each party to the suit was affirmed and quieted and each was enjoined from interfering with the rights of the others.

### SPRING CITY ET AL. v. SPRING CITY IRRIGATION COMPANY ET AL.

This suit, which is pending, has been brought to quiet the title of the water users from Cedar Creek and Twin Creek, a tributary of Cedar Creek, which enters Sanpitch River near the town of Spring City, in Sanpete County. In a suit brought at Provo before statehood the water of Twin Creek was divided by stipulation in a case the name of which search and inquiry failed to disclose. The defendants in the case of Spring City et al. *v.* Spring City Irrigation Company et al. are the users on the upper waters of Cedar Creek, and the plaintiffs the users on Twin Creek and the lower users on Cedar Creek. In July, 1902, the issue on the case had been joined, but the case had not gone to trial.

### WEST POINT IRRIGATION COMPANY v. HANS HANSEN ET AL.

This is an action to restrain the defendants from diverting any of the water of Sanpitch River and Silver Creek between the dam of the plaintiffs and a certain rock dam in sec. 16, T. 15 S., R. 3 E., Sanpete County. January 23, 1890, the complaint was filed in the first Territorial district at Provo. May 21, 1890, a decree was rendered giving to the plaintiffs and defendants from November 15 to July 1 of each year equal parts of the water of Sanpitch River, and to plaintiffs from July 1 to November 1 the entire stream. September 16, 1890, the parties awarded the stream being unable to satisfactorily divide it in accordance with the decree, the court appointed a commissioner for that purpose.

### WEST POINT IRRIGATION COMPANY v. MORONI AND MOUNT PLEASANT IRRIGATING DITCH COMPANY ET AL.

This was an action seeking to enjoin the defendants from diverting the water of Sanpitch River near the town of Fairview, Sanpete County. The complaint was filed August 22, 1895, at Provo. January 15, 1896, Rasmus Clowson filed a complaint in intervention for himself and 100 others, who owned the Ephraim north meadows and claimed a right to water of Sanpitch River. The interveners sought a decree of right and an injunction against both plaintiff and defendants. A demurrer made to the complaint in intervention was sustained by the trial court, but on appeal to the supreme court was overruled. (46 Pacific Reporter, 762.) Although by this action of the supreme court the right of the interveners to enter the suit was established, they did not appear in the further proceedings. A decree was rendered February 11, 1899, substantially in favor of the defendants, and from this decree the intervention of the supreme court was again sought. Among the claims made by the plaintiff and appellant was that it was the owner from November 15 to July 1 of each year of one-half of all the water in Sanpitch River flowing below a certain rock dam near Moroni City and the head of the plaintiff's ditch 5 miles below, and during the remainder of the season the entire flow. The relief sought was not a quieting of title, but an injunction to prevent the defendants from diverting water from Sanpitch River to the alleged injury of the plaintiffs. Between the dams of the plaintiff and the defendants were 5 ditches taking water from the river and owned by parties not appearing in the suit. Water had been drawn through these 5 ditches during the time of alleged unlawful diversion by the defendants, and as no measurements had been made during that time to show what effect these diversions had had on the rights of the plaintiff, so that it was uncertain from the evidence if it was the acts of the defendants alone that had caused the alleged injury, the court saw no ground for reversing the action of the lower court and granting an injunction. Consequently, on March 20, 1900, the judgment of the lower court was affirmed, although without prejudice on the part of the appellants to commence and prosecute another action. (61 Pacific Reporter, 16.)

The law on which the supreme court based its decision, although somewhat complicated, contained one point which is of interest and intelligible to the irrigator. This was that the court would not enjoin an appropriator of water at the head of a stream from diverting water that a lower appropriator might claim unless it should be satisfactorily shown that the water so claimed would have reached the ditch of the lower appropriator had it been allowed to pass down the stream. In other words, the court would require proof of actual injury to the lower appropriator before granting an injunction.

### MORONI IRRIGATION COMPANY v. WILLIAM ZEBRISKIE ET AL.

This suit was brought to quiet title of the Moroni Irrigation Company and about 140 others to the water of Sanpitch River from the town of Moroni, Sanpete County, to the head. September 8, 1900, the complaint was filed, alleging ownership by plaintiffs of a prior right to Sanpitch River up to 60 cubic feet per second and praying for a decree of such right. All of the defendants but one joined in answering

the complaint. July 17, 1901, the findings of fact were handed down by the court. Among these findings were that after June 15 of each year the Sanpitch River did not contain sufficient water to supply the necessities of all parties to the suit; that 1 cubic foot of water per second was necessary for irrigating each 80 acres of land on Sanpitch River; that all parties who by themselves or their predecessors had used water up to and including 1878 had primary rights, denominated the first class, and that the water above the primary rights should be divided into nine classes, each class inferior to all preceding classes, including the first class or primary rights. A decree was rendered in accordance with the findings. This decree provided that when the river should not supply sufficient water to meet the adjudged requirements of any one class the supply available should be divided ratably. A commissioner was appointed to measure the stream and to divide it in accordance with the decree. The title of each party to the suit was quieted and each one was enjoined from interfering with the rights of the others.

### ANDREW OLSEN AND J. ARMSTRONG v. LOUIS JUSTENSEN ET AL.

This was an action for damages and to enjoin the defendants from taking any of the water of Bill Allreds Creek, a tributary of Sanpitch River. May 22, 1886, a decree was rendered by the judge of the first Territorial district, sitting at Provo, decreeing to the plaintiffs all the water of the creek and enjoining the defendants from interfering with its flow and with the flow of certain springs discharging into it.

### MARTIN V. TAYLOR ET AL. v. LAURITZ CHRISTENSEN.

The purpose of this suit was to enjoin the defendant from appropriating or in any manner interfering with the water of Maple Creek, a tributary of Sanpitch River, near the town of Freedom, Sanpete County. May 13, 1895, the complaint was filed, and July 22, 1895, a decree was rendered giving to the plaintiffs a stream of water 36 inches wide and 7 inches deep, with a fall of one-half inch to the rod, and dividing the remainder equally between the plaintiffs and the defendant, with the county surveyor a commissioner to make the division provided for by the decree.

### NIELS THOMPSON v. EPHRAIM CITY ET AL.

This action sought to have the plaintiff, the owner of a mill in Ephraim City, decreed the right to water for his mill from Cottonwood Creek, a small tributary of Sanpitch River, and also sought an injunction against diversion of the water in question by the defendants. March 20, 1899, the complaint was filed. On the same day a decree was entered in accordance with a stipulation of the litigants giving to the plaintiff water for his mill from September 1 of each year until the beginning of the irrigation season of the year following, less certain amounts for stock purposes, and for the remainder of the year $\frac{1}{11}\frac{1}{11}$ of the water in the creek. The title of the defendants was not quieted.

### GUNNISON IRRIGATION COMPANY ET AL. v. NORTH SIXMILE IRRIGATION COMPANY ET AL.

This action sought to quiet the title of the plaintiffs to water of Sixmile Creek, a tributary of Sanpitch River, entering the latter near its lower end. February 27,

1891, the plaintiffs filed their complaint, alleging ownership by the Gunnison Irrigation Company and the Sterling Irrigation Company of three-fourths of the water of the creek in question. May 11, 1891, the court awarded one-half of the water of Sixmile Creek to the Gunnison Irrigation Company, five-sixths of one-fourth to the Sterling Irrigation Company, one-sixth of one-fourth to William Dixon, and the remainder to the other defendants. No mention of the duty of water or the area irrigated is made in the decree.

### GUNNISON IRRIGATION COMPANY ET AL. v. THE STERLING COAL AND COKE COMPANY ET AL.

The purpose of this suit was to quiet title to certain springs at the head of Sixmile Creek. These springs were claimed to be the property of the plaintiffs, Gunnison Irrigation Company, Sterling Irrigation Company, and North Sixmile Irrigation Company, who alleged in their complaint that the springs had been intercepted by the defendants through a tunnel dug under the channel of the creek and above the springs. August 3, 1901, the court found that since the construction of the tunnel numerous springs formerly discharging 2 cubic feet of water per second into Sixmile Creek had become dry, while a large stream of water was flowing from the tunnel mentioned in the complaint. The decree directed that the defendants return 2 cubic feet of water per second to the creek from the tunnel, and quieted the title of plaintiffs to such water and of the defendants to the remainder discharged from the tunnel.

### GUNNISON IRRIGATION COMPANY v. GEORGE PEACOCK ET AL.

This action sought to restrain the defendants from using any of the water of Ninemile Creek, a tributary of Sanpitch River, in Sanpete County, entering the latter a short distance below Sixmile Creek. The complaint was filed February 27, 1891, alleging ownership by prior appropriation by the plaintiffs of all the water in Ninemile Creek, the plaintiffs diverting the water below the mouth of Ninemile Creek and after it became a part of Sanpitch River. May 13, 1891, the court awarded nine-elevenths of one-half of the stream to the plaintiffs and the remainder to the defendants. The duty of water and acreage irrigated were not mentioned in the findings of fact or in the decree.

### GUNNISON IRRIGATION COMPANY v. J. H. CHRISTENSEN ET AL.

An action to restrain the defendants from taking more than three twenty-sevenths of Sanpitch River below the junction of Sanpitch River and Twelvemile Creek. April 18, 1889, the complaint was filed, alleging ownership by the plaintiffs of twenty-four twenty-sevenths of Sanpitch River below Twelvemile Creek. The same day a temporary injunction was issued against the defendants, restraining them, in accordance with the prayer of the complaint, from taking more than their share of the stream. February 25, 1890, the stream was divided by stipulation, giving three twenty-sevenths to the defendants, provided that such three twenty-sevenths should contain no more than sixteen thirty-eighths of the water of Twelvemile Creek. The remainder went to the Gunnison Irrigation Company, the plaintiffs.

## DESERET IRRIGATION COMPANY AND LEAMINGTON IRRIGATION COMPANY v. SAMUEL McINTIRE ET AL.

This suit was originally brought to determine the rights of plaintiffs and defendants to Sevier River between the canal of West View Irrigation Company and the canal of Deseret Irrigation Company. The plaintiffs, whose dams and ditches and use of water were in Millard County, complained of what they alleged was a wrongful diversion of the river in Sanpete County, about 65 miles up the stream from the diversion works of the plaintiffs. When the case went to trial a motion to dismiss, on the ground that the court in Millard County lacked jurisdiction in a case where the injury complained of occurred in Sanpete County, was made by Fayette Canal Company, one of the defendants. The court sustained the motion and the cause was dismissed as to the defendants. From this action the plaintiffs, Deseret Irrigation Company and the Leamington Irrigation Company, appealed to the supreme court of the State, which reversed the decision of the lower court and remanded the cause with directions to set aside the order of dismissal and to entertain the action.

The decision of the supreme court was on a point of much interest, not only to the irrigators on Sevier River, but also to irrigators on every stream passing through more than one county. The counsel for the appellants insisted that the case was properly brought in Millard County, because the dams and ditches of the plaintiffs and appellants were situated in that county, and this regardless of the fact that the principal place of business and the dams and ditches of the defendants were in Sanpete County. The respondents contended that the cause of action consisted of several trespasses on real property situated in Sanpete County, and maintained that under section 5, article 8, constitution of Utah,[a] the suit should have been brought in Sanpete County, where the alleged wrongful acts were stated to have been committed. The respondents also contended that chapter 52, section 14, page 222, of the Session Laws of Utah of 1897[b] was in conflict with this section of the constitution, and hence invalid. The supreme court, however, found no conflict between the sections of the constitution and of the statutes mentioned (16 Utah, 398), and cited authorities to show that where an act committed in one county carried injury to realty in another, suit might be brought in either, and not necessarily only in that county in which the resulting injury occurs. The decision of the supreme court was given February 26, 1898.

Following this decision the case again went to trial, but not until May 16, 1900 The amended complaint supposedly made all users from the stream between the plaintiffs' dam in Millard County to and including the dam of the West View Irrigation Company, a distance of about 65 miles, parties to the suit and sought to quiet title. January 5, 1901, the decision and decree of Judge E. V. Higgins, the trial judge, were rendered.

In the findings from the evidence the court placed the duty of water, with one or two exceptions, at 1 cubic foot per second for each 70 acres of land irrigated. In the decree water was allotted some of the parties on this duty for definite acreages,

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[a] All civil and criminal business arising in any county must be tried in such county, unless a change of venue be taken, in such cases as may be provided by law.

[b] In any action hereafter commenced for the protection of rights acquired to water under the laws of this State, the plaintiff may make any or all persons who have diverted water from the same stream or source parties to such action, and the court may in one judgment settle the relative priorities and rights of all the parties to such action.

directly stated in cubic feet per second, and others were given sufficient to fill ditches of a given cross section and fall. Rights decreed covered springs and tributaries as well as the main stream, and were of several grades. They were: Primary rights to the main stream to the extent of 294⅛ cubic feet per second; secondary rights to the extent of 15⅛ cubic feet per second; primary right to 1⅛ cubic feet per second from springs in Robbins and Ryan meadow, Sanpete County; primary right to water of Sanpitch River diverted 1 mile west of Rocky Point, Sanpete County, to fill a ditch 7 feet wide, 2 feet deep, and falling 2 feet per mile; primary right to springs near the channel of Sevier River at West View, Sanpete County; right to 12⅛ cubic feet per second from Sevier River after the flow of the river and springs, tributaries, and percolating seepage water should reach 310⅛ cubic feet per second; right to fill the Deseret and Salt Lake Agricultural and Manfacturing Company Reservoir to full capacity of 10,000 acre-feet once during high-water season, subject to prior rights to 323⅛ cubic feet per second, this being a prior high-water right; right to 5⅛ cubic feet per second from the main stream during the irrigation season, subject to rights to 323⅛ cubic feet per second and 10,000 acre-feet for the Deseret and Salt Lake Agricultural and Manufacturing Company, and, subject to all of these, right to 57⅛ cubic feet per second. The total extent of rights awarded, primary and secondary, was 380⅛ cubic feet per second, the full capacity of a ditch 7 feet wide, 2 feet deep, and falling 2 feet per mile, and 10,000 acre-feet for storage. In case the stream should not carry sufficient water to supply the awarded primary rights, that water was to be divided ratably between those owning them.

The decree stated the high-water season to be from April 1 to July 1 of each year, and the irrigation season from March 1 to October 1. Weir dams of uniform construction were ordered placed at the head gates of the different ditches, so that water could be measured over them in cubic feet per second, the court adding that "in order to properly distribute the said waters, the head gates of the respective parties * * * shall be so regulated that no greater quantity of water can flow through said head gates than the quantity of which they are herein decreed to be the owner of rights to use." For the purpose of establishing weirs and head gates in the ditches, a commissioner was appointed by the court and arrangements made by which a commissioner should be appointed to distribute the water in accordance with the decree. Each of the parties to the suit was perpetually enjoined from interfering with the rights of the others or from diverting water other than that decreed them. Another section of the decree goes even farther, and, it would seem from the wording, enjoined all parties to the suit from ever after making any further appropriations from the stream or its tributaries. The exact wording of this section (section 22) is:

> That each of the parties to this action, their successors and assigns, be, and they and each of them are, hereby perpetually enjoined and restrained from claiming or asserting any right, title, or interest of, in, or to the waters of said Sevier River, its springs, tributaries, percolating and seepage waters, other than to the interest of which they are respectively herein decreed to be the owners.

It is not probable that it was the intention of the court to make this section of the decree as far-reaching as suggested above. It would be entirely possible for the Sevier River to at sometime carry sufficient water to meet all demands made by

decree and still leave a surplus to be acquired under the State law of appropriation. The interpretation given is, however, the one most natural, and no other would seem to be justified, except by authority of court.

## DISCUSSION OF THE LITIGATION.

The foregoing outline states in brief the purpose, character, and result of the forty suits over water rights on Sevier River and its tributaries during the past sixteen years. With the exception of two or three minor cases, the papers of which are lost from the county records or whose titles search failed to disclose, and the case of Kraft et al. *v.* Conk et al., affecting Sevier River below Deseret, the outline is believed to be complete.

In deciding the efficiency of the litigation on Sevier River in determining rights to water for irrigation, there are obviously two main grounds to consider, (1) has it worked justice between the parties to the litigation; and (2) has it worked justice between the litigants and the public? It is safe to assume that if it has failed on either or both of these grounds it has not been final, because no matter how far-reaching or how well supported by legal doctrine the decrees may be, if they are not right, if the interests of all concerned, whether individual or public, have not been fully and carefully guarded, the time will come when they will be set aside and the issues thrashed over until justice is done. And if it should be found that the litigation has not fallen short on these two grounds, the query would still be pertinent as to whether the process of the courts, counting time and certainty as well as money considerations, has not been more expensive than was necessary or than the benefits which have accrued to the irrigators have warranted.

## EFFECTS OF LITIGATION ON THE RIGHTS OF LITIGANTS.

To answer the first query it will be necessary to refer to some of the significant features of the litigation.

### FAULTY BEGINNINGS OF ADJUDICATIONS.

When a suit seeking the ending of an alleged trespass on a water right or a quieting of title to the water of a stream is filed, it is the practice for the plaintiff to claim adversely to the defendant the entire stream in question, basing the claim, for instance, on an alleged diversion of "all the waters of said river therein flowing from every source whatsoever," and alleging "the actual, peaceable, quiet, undisturbed, adverse, and notorious possession of said waters as against all persons whomsoever," except as interfered with by the defendants. This may be a good beginning for one individual seeking to end a trespass by another, yet it hardly seems a proper way for one hundred or more farmers to commence an action to define their rights to water. While it may have no further effect than opening the case for settlement it would seem that an order from the adjudicating authority directing each irrigator to present testimony as to the date and amount of his use would be more direct and less confusing to the farmers. Such a procedure would also rid the adjudication of the present objectional controversy between the individual irrigators and make an issue between the State and the individual rather than between the individuals. To deter-

mine such simple facts as the capacity of a ditch and the area of land watered by it, facts which a mere survey will show, there seems little necessity or justification for extravagant and untruthful claims. No way for these simple facts to be presented in court by some disinterested officer was found in the course of the litigation on the Sevier. In one case,[a] by consent of the parties interested, the trial judge personally viewed the premises in dispute, but in most cases such action would be impracticable if not inexpedient. In another case,[b] the plaintiffs introduced detailed plats to show the area watered by each party to the suit, and stood ready to support them by testimony of witnesses; yet the plats were not made from actual surveys and were prepared by interested parties, so that there was no assurance before the court other than that of interested witnesses that they were accurate.

### EVIDENCE ON DUTY OF WATER.

As it has been with the area of land watered and the fact of watering, so it has in a measure been with the duty of water. This is equally essential as a basis for adjudication, yet it is not mentioned in many of the Sevier decrees, although the courts have recognized and emphasized its significance in the recent important cases. In one an engineer was employed by one side to ascertain the duty of water in the different districts affected. His report was based on an examination of soil samples and under the circumstances could be no more than approximate. While the information he presented was of great value in the suit and showed that the importance of knowing the duty of water was appreciated, it was far short of a satisfactory basis for settling rights to the extent involved in this case, and should not be allowed to justify such a method when a better one is possible. In one case[c] the court refused to render a permanent decree until such time as a court commissioner should have ascertained by measurement and study what the duty of water was and what the stream in question carried at different seasons of the year. A temporary decree was therefore rendered and a permanent decree will not be signed until the court is assured of its correctness.

### EVIDENCE ON FLOW OF STREAMS.

With perhaps the exception of that just mentioned, in none of the cases of litigation on the Sevier has the importance of a knowledge of the flow of streams adjudicated been recognized, or, if it has been recognized by the court, no steps have been taken or no way found to get this information in reliable form before the court. While there are no instances on the Sevier of the wide discrepancies between the flow of streams and the amount of water decreed, so common until recently in some sections of the West, the evidence on the flow of streams introduced at some of the trials was mere speculation. In most of the recent cases the practice has been adopted of ordering a prorating of the water in a stream among the holders of decreed rights of any class whenever the flow of the stream should fall below the amount decreed to that class. This practice is a natural result of the provision for

[a] Will Cook et al. *v.* Lost Creek Irrigation Company.
[b] Richfield Irrigation Canal Company et al. *v.* Clear Creek Irrigation Company et al.
[c] Miles Durkee et al. *v.* Joseph Brown et al.

prorating among the holders of primary rights in the State statutes.[a] Although it reduces the ill effects of decreeing water in excess of the flow, in no sense does it take the place of an exact knowledge of stream flow based on measurements extending over a sufficient number of years to show a reliable normal. It is of course true that exact information on this subject is not now available, yet it must be available before rights on the Sevier can be settled.

### UNITS OF WATER MEASUREMENT USED.

Hand in hand with defective information as to the flow of streams has gone, until recent years, an ignorance as to the methods of measuring water and the common terms of measurement. Since the State law made the "second-foot" and "acre-foot"[b] legal standards of measurement, the "inches" and "feet" and "cubic inches" have happily largely gone into disuse by courts, although still commonly used among irrigators. In a decree rendered in 1899,[c] a stream of water was given one of the litigants "continuously flowing through an aperture 1½ inches high by 2 inches wide, to be maintained in the extreme lower southeast corner of the dividing box now used * * * for their three-twelfths of said water, the weight of pressure for the said culinary and domestic stream to be determined by the said entire three-twelfths of the waters of said City Creek passing through the said dividing box in the same manner as it does now." If the dividing box remains intact through future generations, if the one who is to distribute the water in years to come understands the specifications as to pressure, and testimony is always available as to what the pressure was "now," then this decree may be said to be at least in a measure definite. A decree rendered in 1897[d] apportioned the water of the Sevier among the litigants when it should become reduced to an amount not exceeding 101 feet, and directed that the water should be measured "by multiplying the width of the water of said canal by the depth of water flowing therein," obviously giving water to an irrigator in proportion to the fall of his ditch.

The practice of awarding water according to the capacity of ditches to carry it, common in early adjudications on the Sevier, is now almost wholly superseded by the more intelligent practice of making awards in the legal standard, the cubic foot per second. The one exception to this in the more recent Sevier River cases was in Junction Irrigation Company *v.* R. D. L. Mitchell, when the plaintiff corporation was given sufficient water to fill its ditch pending an investigation by a court commissioner to determine the capacity of the ditch.

No argument is needed to show that if a decree does not state its awards in intelligible terms, chance will govern in carrying out the decree. It is therefore gratifying to note the care the courts along the Sevier are now giving to this matter.

### COURT DECREES NOT CONCLUSIVE AS TO THE LITIGANTS.

If a decree adjudicating rights to water is to be conclusive, each party to the litigation should, when the decree is rendered, know definitely what his rights are.

[a] Revised Statutes of Utah, 1898, title 33, sec. 1265.
[b] Ibid., secs. 1282, 1283.
[c] E. A. Anderson *v.* W. H. McIntosh et al.
[d] Richfield Irrigation Canal Company *v.* Annabella Irrigation Canal Company et al.

Yet this has not been possible in many of the cases on the Sevier, and only measurably so in the most satisfactory. One decree[a] awards 32 cubic feet per second to 15 defendants, 20 cubic feet per second to 7 defendants, 4 cubic feet per second to 4 defendants, besides other more definite awards; another[b] gives three-tenths of the stream to 13 plaintiffs; another[c] gives nine-twelfths of the stream to 3 parties; another[d] gives to the plaintiffs a stream 36 inches wide, 7 inches deep, with a fall of one-half inch to the rod; still another,[e] after making certain awards, gives "the remainder to the defendants." Such awards as these have simply left the way open for further litigation between those whose rights are merged. In one case[f] an attempt on the part of the attorneys to have the court determine the rights in question simply as between the plaintiffs and the defendants, leaving the individual rights to be settled later, was frustrated by the court unexpectedly awarding to each individual and corporation concerned, whether plaintiff or defendant, a definite, independent right. Those who hoped for further litigation have not yet ceased to find fault with the court's action, although they are compelled to admit its wisdom.

The decrees are not conclusive as between the litigants in another way. No decree has been rendered on the Sevier which is not liable to lose a part or all of its force by a later decree. It is doubtful if in one of the suits that have been brought to quiet title a majority of the water users concerned did not believe the suit was going to settle their rights so conclusively that they could never again be assailed in court. Yet this has not been the result in even the two most important cases brought to quiet title which have been decided—Richfield Irrigation Canal Company et al. *v.* Clear Creek Irrigation Company et al., affecting the Sevier from the dam of the Vermilion Irrigation Company in the lower Sevier Valley to the headwaters of East Fork in Garfield County; and Deseret Irrigation Company et al. *v.* Samuel McIntire et al., affecting the Sevier from the canal of the West View Irrigation Company in Sanpete County to Deseret in Millard County. Many of the rights decreed in the first-named case are already being assailed in the case of Richfield Irrigation Canal Company et al. *v.* Circleville Irrigation Company et al., and the rights decreed in the other are sure to be questioned, if not in a suit affecting the water both below and above the canal of the West View Irrigation Company in Sanpete County, then in a suit which, if conditions continue as in the past, will come when water is more valuable and in greater demand for the wide areas of tillable land on the Sevier desert below the town of Deseret.

That issue will be taken with this statement is not doubted, yet if the history of past litigation on the Sevier is any guide to the future, there can be little question of its truth. No water user's rights are certain until they are established good against all the world. A civil suit in law can affect only those who are parties to it. If only a portion of those using or claiming the right to use water from a stream or its supply are concerned, as has been the case in every suit thus far prosecuted on

[a] Otter Creek Reservoir Company et al. *v.* Koosharem Irrigation Company et al.
[b] Koosharem Irrigation Company et al. *v.* Frank Bush et al.
[c] E. A. Anderson *v.* W. H. McIntosh et al.
[d] Martin V. Taylor et al. *v.* Lauritz Christensen.
[e] Gunnison Irrigation Company et al. *v.* North Sixmile Irrigation Company et al.
[f] Richfield Irrigation Canal Company *v.* Clear Creek Irrigation Company et al.

the Sevier, there is no possible way to prevent the rights established in one suit from being assailed in another. And the longer such an imperfect decree remains in force the greater is the injury done, because it deceives those affected into believing that permanent which in the nature of the case can not be so, a result which only too often engenders distrust of even that which is permanent.

Under the statutes of Utah a plaintiff may make any or all persons who have diverted water from the same stream or source parties to one suit;[a] or if interested parties are not represented they may enter the suit, on leave of the court, by filing a complaint in intervention, joining with either the plaintiff or the defendant or making demands adversely to both;[b] or their appearance may[c] be ordered by the court when a complete determination of the rights can not be had without their presence.[d] It is therefore rather surprising to still find suits being prosecuted which do not include even all of those using water from the immediate tributary or section of the stream. It must be said, however, that these suits are rather the exception than the rule, because the seven most extensive suits on the Sevier have aimed to include all irrigators within the territory embraced by the suit, even if they did not include all of the tributaries or all of the stream, as already explained.

### ESTABLISHING WATER RIGHTS BY STIPULATION.

A practice in water litigation on the Sevier which is common, and whose demoralizing influence is admitted and deplored by many, is that of settling the litigation by stipulation of the parties to the suit. In 12 of the 40 cases the final settlement was effected in this manner, while in a number of others, notably that of Richfield Irrigation Canal Company et al. *v.* Clear Creek Irrigation Company et al., stipulation was resorted to to settle some of the rights. In this case a committee of the plaintiffs, under direction of their attorney, visited each defendant appropriator in the case and endeavored to reach an agreement with him as to what amount of water he was entitled to. In some cases no agreement could be reached, but where one was possible, the following stipulation was signed by the defendant and the attorney for the plaintiff:

> It is hereby stipulated by the plaintiffs and the defendant, —— ——, that said defendant has for more than seven years prior to the filing of this action, used, and is entitled to a decree herein confirming his right to the use of sufficient of the waters of —— to irrigate —— acres of land in —— County, Utah.
>
> That —— cubic feet per second of time, measured at said defendant's head gate in said stream, is the amount required to properly and economically irrigate said land, and the manner in which said water shall be regulated and controlled in the said use is the only issue herein which the court is called upon to determine between the plaintiffs and the said defendants.

While agreement out of court is in many respects preferable to contention in court, there is a point to which this agreement can not, in justice to all, be carried. That point is reached when stipulation is attempted between a well-selected committee representing a number of strong irrigation companies seeking control of all of the water that it is possible for them to get and an individual farmer who probably knows

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[a] Revised Statutes of Utah, 1898, title 33, sec. 1274.
[b] Ibid., title 73, chap. 6, sec. 2925.
[c] The statute makes this compulsory.
[d] Revised Statutes of Utah, 1898, title 73, chap. 6, sec. 2926.

very little as to his requirements for irrigation when stated in cubic feet per second or any other definite unit of measurement. A stipulation under such conditions might or might not be fair to the individual, but even if it were, it might or might not be fair to the other parties of the suit. Such a committee would doubtless have a limit beyond which it would not go in conceding a right. Up to that limit, the quantity of water which each claimant would receive by the stipulation will depend more on his assertiveness than on his right, and there will be no necessary uniformity in the basis of rights recognized by the stipulation. Obviously, the same standard should measure all like rights, and it is not to be expected that that standard will be applied by anyone other than a disinterested person. While it may lessen the expense and trouble of settling a controversy in court to have one-half of it settled outside of court, there will be no assurance when a decree is rendered that the rights settled in court correspond to the rights settled outside.

Besides the injustice sure to follow the lack of a uniform basis in determining rights to the same stream there is a further objection to such stipulation as used in the case of Richfield Irrigation Canal Company et al. *v.* Clear Creek Irrigation Company et al., cited above. This arises from the possibility that such a stipulation may in a later suit be held to have determined only the rights between the parties to the stipulation. No case purporting to settle all of the rights on a stream has been found in which a stipulation has been held not binding on those not agreeing to it, and the natural inference is that when the court, in determining from the evidence the rights of the individual users, embodies these stipulations in his decree, they become final in the eyes of the law because not questioned during the progress of the trial. The injustice of such a ruling, however, warrants a doubt if, when once tested, it would not be overthrown and the rights between the parties entering and those not entering the stipulation left again in doubt.

The objections to the settlement of all rights to a stream by stipulation are of a somewhat different nature. At the end of a complicated and protracted water suit, after each side in the suit has reached the limit to which it can go in its testimony, it is quite common for a stampede of stipulations to begin which will perhaps end only when the whole available supply of water has been divided, without regard, perhaps, to much of the testimony that has been introduced in the trial, or at any rate without regard to the real duty of water or the rights of appropriators not represented, or of those who may desire a few years later to reclaim some of the desert land lying under the stream in question. The result is very liable to be that the rights of the weakest in defense are considerably reduced from what they would have been had the court, after a careful examination of all the testimony, made a systematic award. It is of course urged in defense of such a stipulation that those making it would not consent to it if their rights were not protected, yet it is a fact that this is not always the case, because it sometimes happens that those whose rights are stipulated are not represented by attorneys. There is on record an order of court emphatically refusing to sanction a decree stipulating away the rights of unrepresented parties "simply because some of them have refused to hire an attorney and pay out four or five times what their water is worth in order to employ them."[a]

[a] Miles Durkee et al. v. Joseph Brown et al.

One farmer shrewder than others may gain water on a lower duty than others, with the same resulting variance in the basis of awards as in the stipulations out of court. The acquiescence of the less shrewd is no excuse for the public failing to protect him.

Although the lack in uniformity resulting from stipulation may be serious, the injury to the public is far more so. To have the appropriators from a public stream divide its water among themselves under sanction of the court has no justification. Under such a practice those taking water from a stream, even if they do not use half its water, may agree to a division of the whole supply among themselves, and in that way acquire title to public property, not from the public and by use, as the law provides, but from each other and by agreement. The stream is the property of the public, and should be carefully conserved in the interests of future appropriators, yet there is on record in the Sevier River cases no action by a court looking to protection of the rights of the public, and it is doubtful if such action is authorized by statute.

### APPOINTMENT OF COURT WATER COMMISSIONERS.

In nearly one-half of the cases decided on the Sevier, the courts have appointed water commissioners to distribute the water decreed. In recent cases a civil engineer has been selected for this work and jurisdiction retained by the court for making new appointments as necessary, or for otherwise enforcing the decree. In some cases the appointment of a commissioner has been requested of the court. On one occasion a carpenter was appointed commissioner, probably for his ability to make division boxes, and on another occasion the county surveyor was the one selected. In Richfield Irrigation Canal Company et al. *v.* Annabella Irrigation Company et al., the court made provision for the appointment of a commission of representatives of the canal companies and individuals affected to attend to the distribution. In every case it has been ordered that the parties benefited pay pro rata the salary and expenses of the commissioner. The law[a] passed by the Utah legislature in 1901, empowering boards of county commissioners to divide the counties into water districts in accordance with established priorities, has not been complied with in any of the counties through which the Sevier flows, except in Juab County, and not there so as to affect Sevier River water.

### BENEFICIAL USE THE BASIS FOR ADJUDICATIONS.

The doctrine that beneficial use should be the basis of rights to water has been the ruling doctrine in Sevier River adjudications. Priority of appropriation has not been adhered to closely, because of the lack of definite testimony as to the dates of appropriations. In some of the decrees the plan has been adopted of making seven years' use the requirement for a primary right.[b] This is in accordance with the provisions of an earlier statute,[c] and is followed reluctantly by the courts. The statutes now in force[d] make all rights up to the average low-water flow of a stream primary, and whenever the stream falls below that average the water is prorated among them,

[a] Session Laws 1901, chap. 125, secs. 13, 14, and 15.
[b] E. g. Richfield Irrigation Canal Company et al. v. Clear Creek Irrigation Company et al.
[c] Compiled Laws of Utah, 1888, sec. 2870.
[d] Revised Statutes of Utah, 1898, title 33, sec. 1265.

but in the adjudications referred to it was not always possible to include among those having primary rights only the appropriations up to low water.

The case of Monroe Town *v.* Andreas Bertelsen et al. offers an exception to the general practice of adjudicating rights on the doctrine of actual beneficial use. The decree in this case gave a right of 11 cubic feet per second to a canal still under construction at the time of the award.

## CONFLICTS AND REPETITIONS IN COURT DECREES.

On the Sevier there have been many conflicts and repetitions in the decrees. These have been of several kinds, and in some cases have been and are still the cause of uncertainty and controversy. To more clearly show them a summary is inserted below of the forty cases of litigation already outlined in greater detail. While conflict is not noticeable in all of the cases, all are included in the summary for the sake of other characteristics they present.

*Summary of litigation.*

1. Stream, East Fork; title of case, John F. Steele *v.* Tropic and East Fork Irrigation Company; award, all of stream.

2. Streams, Birch, Ranch, and Horse creeks, tributaries of East Fork; title of case, Isaac Riddle *v.* Wadkin Reese et al.; award, all of Birch, Ranch, and Horse creeks.

3. Stream, Cottonwood Creek, tributary of East Fork; title of case, Hyrum Williams *v.* J. S. Riddle et al.; award, pending.

4. Stream, Otter Creek, tributary of East Fork; title of case, James E. Forshee et al. *v.* Nels Johnson et al.; award, all at dam of plaintiffs.

5 Stream, same; title of case, Koosharem Irrigation Company et al. *v.* Frank Bush et al.; award, all at mouth of canyon above land of defendants.

6. Stream, same; title of case, E. Anderson et al. *v.* H. McMullin et al.; award, all of stream.

7. Stream, same; title of case, Otter Creek Reservoir Company et al. *v.* Koosharem Irrigation Company et al.; award, primary rights to 66¼ cubic feet per second entire year and 55¼ cubic feet per second April to June; all Cedar Grove Springs, reservoir of B. C. I. & R. Company in Beaver Creek; secondary rights to 90.7 cubic feet per second; third rights to 1 cubic foot per second 72 hours and 0.5 cubic foot per second 84 hours in March, April, May; fourth right to fill Otter Creek Reservoir from Otter Creek.

8. Stream, Asays and Mammoth creeks and South Fork above dam of East Panguitch Irrigation Company; title of case, The Long Canal Company and the East Panguitch Irrigation Company *v.* Parle Henrie et al.; award, first class, 85.04 cubic feet per second; second class, 16.69 cubic feet per second; third class, 13.18 cubic feet per second; fourth class, 9.06 cubic feet per second.

9. Stream, South Fork; title of case, Circleville Irrigation Company et al. *v.* Orson Dalton et al.; award, all between head of M. Parker Ditch and J. Whittaker Ditch.

10. Stream, springs on South Fork; title of case, Junction Irrigation Company *v.* R. D. L. Mitchell; award, capacity of canal of Junction Irrigation Company and small stream.

11. Stream, City Creek, tributary of South Fork; title of case, E. A. Anderson *v.* W. H. McIntosh et al.; award, all of stream.

12. Stream, Thibidau Creek, tributary; title of case, D. C. Thompson *v.* M. Smith et al.; award, all of stream.

13. Stream, Manning Creek, tributary; title of case, A. J. Sargent and H. E. Lisonbee *v.* Henry Nelson et al.; award, all of stream.

14. Stream, Cottonwood Creek, tributary; title of case, H. E. Lisonbee et al. *v.* John Dennis et al.; award, all of stream.

15. Stream, Tenmile Creek, tributary; title of case, Joseph Chesselle *v.* Joseph Howes et al.; award, all of stream.

16. Stream, same; title of case, Martha H. Pitts *v.* J. Chesselle et al.; award, entire stream 86 hours out of every 100 hours.

17. Stream, Monroe Creek, tributary; title of case, Monroe Town *v.* Andreas Bertelsen et al. Award, primary rights to 8.7 cubic feet per second; second rights to 21$\frac{1}{11}$ cubic feet per second; third rights to 11 cubic feet per second; entire stream for milling, subject to irrigation rights.

18. Stream, Bullion Creek, tributary; title of case, Miles Durkee *v.* Joseph Brown et al.; award, normal and first, second, and third stages of high water, to owners of 1,053 acres, on duty of water of 1 cubic foot per second to each 70 acres.

19. Stream, Sevier River, from Nilsson Dam to Vermilion Dam, in Sevier Valley; title of case, Richfield Irrigation Canal Company *v.* Annabella Irrigation Canal Company et al.; award, 101 "feet" measured "by multiplying the width of the water of said canals by the depth of water flowing therein."

20. Stream, Sevier River and tributaries, from Vermilion Dam, in Sevier Valley, to headwaters of East Fork, in Garfield County; title of case, Richfield Irrigation Canal Company et al. *v.* Clear Creek Irrigation Company et al.; award, primary rights to 364.83 cubic feet per second; secondary rights to 68 cubic feet per second; third rights to 47 cubic feet per second; fourth rights to 7.10 cubic feet per second; all of Tenmile Creek; all of Bullion Creek; all of East Fork at dam of Kingston Irrigation Company; all of Beaver Creek.

21. Stream, Sevier River and tributaries, from Vermilion Dam, in Sevier Valley, to headwaters of South Fork, in Garfield County; title of case, Richfield Irrigation Canal Company et al. *v.* Circleville Irrigation Company et al.; award pending.

22. Stream, Lost Creek, tributary; title of case, Lost Creek Irrigation Company *v.* ———; award, ———.

23. Stream, same; title of case, Will Cook et al *v.* Lost Creek Irrigation Company; award, 25 cubic feet per second.

24. Stream, same; title of case, Rex *v.* Lost Creek Irrigation Company; award, pending appeal.

25. Stream, Yogo and Neoche creeks, tributaries of Salina Creek, tributary; title of case, Salina Creek Irrigation Company *v.* Salina Stock Company; award, all of stream.

26. Stream, springs, tributary to Willow Creek, tributary; title of case, Willow Creek Irrigation Company et al. *v.* Sarah C. Michaelson; award, all of springs.

27. Stream, Birch Creek, tributary of Sanpitch River, tributary; title of case, Birch Creek Irrigation Company et al. *v.* Delbert Terry et al.; award, all of stream up to 61.5 cubic feet per second.

28. Stream, Canal and Oak creeks, tributaries of Sanpitch River, tributary; title of case, Chester Reservoir Ditch Company et al. *v.* Spring City et al.; award, all of stream.

29. Stream, Twin and Cedar creeks, tributaries of Sanpitch River, tributary; title of case, Spring City et al. *v.* Spring City Irrigation Company et al.; award pending.

30. Streams, Silver Creek, tributary of Sanpitch River, and Sanpitch River, tributary, between dam of plaintiffs and rock dam in sec. 16, T. 15 S., R. 3 E., Sanpete County; title of case, West Point Irrigation Company *v.* Hans Hansen et al.; award, all of streams.

31. Stream, Sanpitch River, tributary, near town of Fairview, Sanpete County; title of case, West Point Irrigation Company *v.* Moroni and Mount Pleasant Irrigation Ditch Company; award, none; injunction sought denied.

32. Stream, Sanpitch River, tributary, from Moroni town to headwaters; title of case, Moroni Irrigation Company *v.* William Zebriskie et al.; award, all of stream.

33. Stream, Bill Allreds Creek, tributary of Sanpitch River, tributary; title of case, Andrew Olson and J. Armstrong *v.* Louis Justensen et al.; award, all of stream.

34. Stream, Maple Creek, tributary of Sanpitch River, tributary; title of case, Martin V. Taylor *v.* Laurits Christensen; award, all of stream.

35. Stream, Cottonwood Creek, tributary of Sanpitch River, tributary; title of case, Niels Thompson *v.* Ephraim City et al.; award, all of stream for milling purposes from September 1 of each year to beginning of following irrigation season, and $\frac{1}{11}\frac{1}{11}$ of creek remainder of year.

36. Stream, Sixmile Creek, tributary of Sanpitch River, tributary; title of case, Gunnison Irrigation Company et al. *v.* North Sixmile Irrigation Company et al.; award, all of stream.

37. Stream, springs at head of Sixmile Creek, tributary of Sanpitch River, tributary; title of case, Gunnison Irrigation Company et al. *v.* The Sterling Coal and Coke Company et al.; award, all of springs.

38. Stream, Ninemile Creek, tributary of Sanpitch River, tributary; title of case, Gunnison Irrigation Company *v.* George Peacock et al.; award, all of stream.

39. Stream, Sanpitch River, tributary, below mouth of Twelvemile Creek, and Twelvemile Creek; title of case, Gunnison Irrigation Company *v.* J. H. Christensen et al.; award, all of stream.

40. Stream, Sevier River, from canal of West View Irrigation Company, in Sanpete County, to canal of Deseret Irrigation Company, in Millard County; title of case, Deseret Irrigation Company and Leamington Irrigation Company *v.* Samuel McIntire et al.; award, primary and secondary rights to 380⅛ cubic feet per second; 10,000 acre-feet; capacity of ditch, 7 feet wide, 2 feet deep, with fall of 2 feet per mile.

It is not possible to detect from the records every case of conflict and repetition, but enough are plain to illustrate the nature of the results obtained from the litigation.

In cases Nos. 8, 9, 10, and 11, rights were decreed to all of South Fork of Sevier River and tributaries from City Creek, below Junction, to the headwaters of the South Fork, including Asays and Mammoth Creeks. These rights are all assailed in case No. 21, now pending.

In case No. 15 all of Tenmile Creek was awarded, yet eighty-six one-hundredths of this stream was re-awarded in case No. 16, and the whole stream again in case No. 20.

In case No. 18 the entire normal flow and first, second, and third stages of high water of Bullion Creek were awarded. Case No. 20 awards the same stream on a different basis.

In case No. 19 the entire Sevier River in Sevier Valley between the Nilsson and Vermilion dams up to 101 "feet" was decreed. The same rights were decreed on a different basis in case No. 20, and are at issue a third time in case No. 21, now pending trial.

The conflicts between the decrees in cases Nos. 18 and 20 and 19 and 20 will bear close examination. The decree in case No. 18 awarded the entire flow of Bullion Creek in four distinct classes, each subordinate to the preceding class, to the owners of 1,053 acres of land, on a duty of water of 1 cubic foot per second to each 70 acres of land, aggregating an award of 15.04 cubic feet per second. By the terms of the decree a court commissioner was appointed to divide the water of the creek. In case No. 20 when the water of the stream was re-awarded, but two classes of rights, primary and secondary, were awarded. In case No. 18, Bullion Creek was awarded independently of the Sevier and its other tributaries, but in case No. 20 the primary rights were placed on the same footing with primary rights on the main Sevier, so that if there should be insufficient water in the Sevier and its tributaries to supply the 364.88 cubic feet per second primary rights awarded, Bullion Creek must be prorated with the rest of the Sevier. The flow of Bullion Creek coming from a watershed furnishing late water, when distributed independently of the stream, in ordinary seasons carries water sufficient to supply the awards in the decree in case No. 18 some weeks after there is an acute shortage in the main Sevier for the canals taking water in the Sevier Valley below the mouth of Bullion Creek. When the shortage is felt in the lower valley a demand is immediately made for the water of Bullion Creek to be prorated along with the rest of the tributaries, and according to the decree in case No. 20, it is the business of the court commissioner appointed by that decree to see that Bullion Creek is prorated. It is equally the business of the commissioner appointed in case

No. 18 to see that Bullion Creek is not prorated. It is held by some of the lower appropriators that before case No. 20 was decided, the rights of the users from Bullion Creek as against appropriators from the main Sevier had never been adjudicated, which is true. But it is claimed on behalf of the Bullion Creek appropriators that being situated above the main Sevier, they are not in a position to profit by high water there, and that therefore they should not be deprived of what high water Bullion Creek carries late in the season, a contention that is certainly not without merit. It is also clear in the minds of those who make this claim on behalf of the Bullion Creek appropriators that if they must share the late water of Bullion Creek with the irrigators in the Sevier Valley, in spite of the impossibility of diverting Sevier River high water to the land on Bullion Creek, the irrigators in the lower valley should be made to pay the Bullion Creek farmers for that part of the early high water of Sevier River to which they would be entitled under the decree were it possible for them to divert it to their fields. What the outcome of the difference will be or how soon the two court commissioners will be on strained relations, is not now clear, but the conflict is a striking example of the difficulties which will always attend attempts to reconcile by court decrees the diverse and conflicting interests of water users from the same water system.

The cause of the conflict in these cases was in part due to their being tried by different judges. Both cases arose in the sixth judicial district, but through disqualification of the judge of that district to try case No. 20 the judge from a neighboring district was called in. The conflict was also due to an absence of testimony in the trial of case No. 20 to show the injustice to be done the Bullion Creek appropriators by classing their rights with those on the main stream.

The conflict between the decrees in cases Nos. 19 and 20 was of a different nature. The awards in case No. 19 were not sufficiently clear as to leave no question about their meanings, but they have been construed so as to make them in a measure definite. The decree in case No. 19, known as the Higgins decree, gave, for instance, to the Monroe Irrigation Company 19 per cent of the flow of Sevier River whenever it should reach an amount not exceeding 101 "feet," measured by depth and width without regard to velocity. The decree in case No. 20, known as the Johnson decree, awarded to the Monroe Company 40.5 cubic feet per second. It is now claimed that the 40.5 cubic feet per second awarded by the Johnson decree is about one-fourth less than the 19 per cent awarded by the Higgins decree. Some of the other companies who have appeared in both suits also claim to have lost by the Johnson decree. An effort will therefore be made in the suit now pending, Richfield Irrigation Company et al. *v.* Circleville Irrigation Company et al., which will have to reconsider the awards of the decrees in cases Nos. 19 and 20, to establish the validity of the Higgins decree as against the later Johnson decree. This effort is being made on the theory that, notwithstanding the partial indefiniteness of the Higgins decree, that is certain which can be made certain, and, further, that once the possible definiteness of the Higgins decree is established it must remain the law as against all other decrees for the reason that the six months allowed by the Utah statutes for appeal from a decree passed without an appeal being taken. This question is likely to assume some importance in the pending trial. Those opposed to having the Higgins decree take precedence over the Johnson decree claim that if the Monroe Irrigation Company and others

were deprived by the Johnson decree of water awarded them by the Higgins decree they were deprived of water that did not rightfully belong to them, because the Johnson decree took into consideration the duty of water, which the Higgins decree did not.

### EFFECTS OF THE LITIGATION ON THE RIGHTS OF THE LITIGANTS.

Reviewing the foregoing discussion to determine if the litigation has worked justice to those concerned in it, the conclusion seems warranted that it has not to the extent it should have done. While the later decrees show a marked improvement over those of early date, an improvement that has been brought about by careful and conscientious courts, there are certain defects which nothing short of a change in system can remove. Broadly these are (1) the impossibility for disinterested testimony to be placed before the adjudicating authority as to such simple but fundamental matters as duty of water, acreage irrigated, and the time water was used; and (2) the apparent impossibility for decrees to be rendered which are not only not conclusive between the parties to a particular suit, but which conflict in some important feature with other suits and leave open to further litigation that which the decrees were intended to settle. Unless the courts are vested with authority to handle water adjudications so as to take them up in an orderly and comprehensive way and ascertain through disinterested examination the physical data which is of first importance if the adjudications are to work justice between the litigants, there seems no other conclusion than that they should not hold jurisdiction. In other words, before it can be truthfully said that those who seek through the courts a settlement of their rights to water for irrigation can have assurance of getting it, adjudications will have to be based on a fuller and more exact knowledge of facts than the courts have yet been able to bring before them in the Sevier River litigation.

### EFFECTS OF LITIGATION ON THE RIGHTS OF THE PUBLIC.

There yet remains to be considered the effect of the litigation on the Sevier on the rights of the public.

In the early part of this report attention was called to the fact that Sevier River and its tributaries form the principal water system of the central part of the southern half of Utah, and that they are the chief source of agricultural productiveness for the five counties of Garfield, Piute, Sevier, Sanpete, and Millard. In 1896 the State land board of Utah reported that in ordinary years sufficient water runs to waste from drainage of the Sevier River basin to irrigate half a million acres of land, and that there are excellent and ample facilities for storage, the field party of the board having found sixteen reservoir sites along the stream and its tributaries. The main body of the irrigable land the board found to be in the Sevier desert, which is a valley of some 1,200 square miles lying chiefly in Millard County. It seems, therefore, that if the estimates of the land board are correct, when the valley of the Sevier is developed to its possible extent it will comprise an area of irrigated land two-thirds the size of Rhode Island. According to the Twelfth Census there were in 1899 in the five counties but 149,084 acres of irrigated land, covered by 212 ditches aggregating a length of 697 miles. Data gathered in 1902 show that there are approximately that number of ditches on the Sevier and its tributaries alone. Comparing the possible half-million acres with the acreage given by the census shows

that the two are far apart, and that there are many homes yet to be made on the banks of the Sevier and its tributaries.

Under present irrigation practice the limit of development without stored water has been reached. The fact that reservoirs have been found necessary and have been built, as well as the large number of decrees that have awarded all the normal flow, show this. The area of irrigable land yet uncultivated and the volume of flood waters yet unavailable for irrigation leave no other conclusion than that the problem of the future is the problem of the floods. These will have to be controlled and the water spread in proper season over the unclaimed areas of the basin. After the natural flow of streams is appropriated, development is comparatively slow in even the most fertile valleys. The difficulties presented along the Sevier will make that true on this stream. The man who appropriates the last available irrigation stream from the Sevier basin will therefore not be of this generation, but of that of twenty or forty or perhaps one hundred years hence. That man has rights in this basin, because the title to the water he will one day use must have its foundation in the present if not in the past. The only possible representative of the yet unknown appropriator is the public, and that public will one day be called to account for its stewardship. If its trust is mismanaged, the penalty will be a just condemnation of its methods. The first requisite of good management is control of the property to be managed. If the public does not control its property, it can not expect the results of its stewardship to be satisfactory, yet, with the interests of hundreds of future water users in its hands, that public is now exercising absolutely no control over the water of the Sevier. A careful study has failed to disclose one case of litigation on this stream in which the interests of the public were given any protection whatever. If a duty of water was to be determined for any locality, the duty agreed upon by those already using water was the duty adopted by the court; if an entire stream was to be adjudicated, those who happened to be already on the ground were allowed to stipulate a division of the stream among themselves; if a portion of the water that fell on public lands was, after it had been collected into floods, to be awarded to any individual or company, it was awarded without regard to how it was to be distributed or what relation it should bear to the rights of appropriators farther down the stream. The litigation has not protected the rights of the public because those rights are not recognized by law. Yet that such rights exist on the Sevier is as apparent as is the fact that individual rights exist.

## CONCLUSIONS.

The litigation on the Sevier discloses no necessity for revolutionary legislation, yet there is no question that the irrigation laws should be changed so as to insure placing before the adjudicating tribunal efficient and disinterested testimony regarding the rights of individuals sought to be adjudicated, and also so as to protect the rights of the public. No law will accomplish this which does not embody the following principles:

(1) That rights which have accrued under the laws that have been or are on the statute books are valid, and are entitled to protection from the public.

(2) That control of the water of the public streams, both before and after it is diverted, shall forever be vested in the public, and that henceforth property rights to water shall not accrue.

(3) That no right to water for irrigation or any other useful purpose shall be decreed without the public being represented in the proceedings by which that right is established, and that stipulations or other mutual agreements between those seeking an adjudication of their rights shall neither be permitted nor sanctioned.

(4) That no part of any stream shall be adjudicated without due and proper consideration of the remainder of that stream or its tributaries, both in normal and flood flow.

(5) That surveys made under public authority furnish the only direct and proper testimony as to the area of land watered, and that no testimony other than public surveys shall be accepted to establish the fact.

(6) That no adjudication of right to a stream shall be made without a knowledge of the usual normal and flood flow of that stream and of the duty of water on the stream, such knowledge to be based only on measurements and surveys made under public authority.

(7) That no right shall be given to any land for water in excess of the actual requirements of that land.

(8) That henceforth no diversion from any public stream or water source shall be made without specific authority from the public, and that, if for irrigation, such authority shall be given for only so much water as is necessary for such irrigation; provided, that henceforth the fact of use alone, without specific authority from the public, shall in no wise establish a right.

It is believed that a law could be framed embodying the above principles that would not upset existing conditions on the Sevier or take away from any water user that which is rightfully his. While it would alter the decreed rights of some, it would work no injury because any rights that the new law would affect are sure to be altered by future decrees under the present law. By considering all essential physical and economic facts, the new law would simply do well what past experience on the Sevier has proved the present law would do ill if allowed to stand. By what system the new principles should be put into operation, whether the necessary public authority should be exercised by the State or by the counties, or by some quasi-public organization of all the water users in the separate watersheds, is a matter that will have to be decided by the legislature of Utah in the light of local conditions. Early customs which have laid the foundations for institutions must be given full consideration, but in no sense should they be allowed to impede needed reforms. If conditions are improved, wrong principles will have to be squarely faced and not excused by pointing to the development of the past. The development of agriculture on the Sevier during the next generation is bound to be slower than during the past, and will require more encouragement. Twenty years ago when a farmer was deprived of his water supply through a faulty court decree, he could move to an adjoining settlement where the supply was ample, and there develop a new farm at small expense. This is no longer possible, because the normal flow of the stream is either all used or all appropriated. To deprive a farmer of his irrigation water is to deprive him of his fortune; to prevent his acquiring title to water when there is water available is to prevent his making one. He can no longer succeed in spite of defects in the irrigation law.

# APPROPRIATION OF WATER FROM LOGAN RIVER.

By GEORGE L. SWENDSEN,
*Professor Irrigation Engineering, Utah Agricultural College.*

It is the object, in the following discussion, to outline the methods of canal operation on Logan River, to call attention to the public records of claims to water, and to bring together such other facts and information relative to irrigation interests as to make clear the conditions which regulate, successfully or unsuccessfully, the division of the water of this stream among the appropriators.

Information has been gathered from public records, canal company records, private correspondence, various field observations and measurements, and from such other sources as afford material bearing on the subject. Acknowledgments are due for the aid given by county officials, court officers, canal officers, and others who have shown their interest in the work.

## VOLUME OF DISCHARGE.

In the following table the maximum, minimum, and mean monthly discharges of the river are given in cubic feet per second from June, 1896, to September, 1900, as compiled from the United States Geological Survey reports. The figures have been corrected for the discharge of the Logan, Hyde Park, and Smithfield Canal, which is taken out at a point above the gauging station on the river, so that the table gives the entire water supply of the river for the years named. There are no records of measurements of the river prior to 1896.

*Discharge of Logan River in cubic feet per second, 1896–1900.*

| Month. | 1896. | | | 1897. | | | 1898. | | | 1899. | | | 1900. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Max. | Min. | Mean. | Max. | Min. | Mean. | Max. | Min. | Mean. | Max. | Min. | Mean. | Max. | Min. | Mean. |
| January | ..... | ..... | ..... | ..... | ..... | 170 | 187 | 162 | 172 | 175 | 145 | 162 | 220 | 130 | 322 |
| February | ..... | ..... | ..... | ..... | ..... | 170 | 177 | 153 | 162 | 249 | 128 | 162 | 200 | 170 | 167 |
| March | ..... | ..... | ..... | ..... | ..... | 170 | 187 | 153 | 159 | 212 | 163 | 173 | 262 | 157 | 242 |
| April | ..... | ..... | ..... | 790 | 180 | 347 | 702 | 156 | 305 | 395 | 184 | 294 | 455 | 282 | 294 |
| May | ..... | ..... | ..... | 1,863 | 800 | 1,304 | 807 | 447 | 639 | 770 | 335 | 584 | 1,114 | 405 | 710 |
| June | 1,900 | 855 | 1,809 | 1,724 | 677 | 1,080 | 780 | 540 | 710 | 2,250 | 710 | 1,460 | 1,006 | 475 | 791 |
| July | 860 | 408 | 606 | 710 | 437 | 548 | 512 | 229 | 345 | 1,725 | 630 | 845 | 490 | 259 | 370 |
| August | 408 | 341 | 366 | 437 | 310 | 356 | 309 | 216 | 274 | 614 | 395 | 486 | 292 | 267 | 282 |
| September | 315 | 227 | 303 | 370 | 310 | 315 | 256 | 207 | 222 | 395 | 304 | 340 | 280 | 230 | 262 |
| October | 272 | 248 | 270 | 325 | 295 | 304 | 212 | 197 | 200 | 294 | 259 | 280 | ..... | ..... | ..... |
| November | 262 | 236 | 239 | 295 | 245 | 252 | 187 | 172 | 176 | 295 | 209 | 210 | ..... | ..... | ..... |
| December | 238 | 213 | 234 | 245 | 170 | 208 | 217 | 128 | 145 | 280 | 205 | 217 | ..... | ..... | ..... |

## WATER RIGHTS ON LOGAN RIVER.

The conditions that have governed irrigation development on Logan River are probably typical of those in nearly every locality of the State, and a mention of some of them will be necessary to a discussion of the water rights in that stream.

In the spring of 1860 the first ditch for the diversion of Logan River water was projected, and by the united labor of a number of farmers water was diverted sufficient to irrigate about 800 acres of wheat. No organization of those interested seemed necessary, nor was judicial sanction sought for the right to so divert a portion of the stream.

In the next year another canal was projected on exactly the same plan, and by other ditches built in 1865, 1880, and 1883, together with the enlargements that have been made, the river now supplies water to irrigate more than 13,000 acres of land.

### RECORDS OF APPROPRIATIONS.

Owing to the fact that all of the canals diverting the waters of this stream were built before the passage of a law requiring claims to be recorded, the county records are incomplete and indefinite. Until 1880 no provision whatever was made for the recording of claims to water, and though the law passed in that year was declared void after it had been in force for ten years, it had the effect of creating some interest among appropriators in the question of water-right records. Subsequent to its repeal in 1890 there was filed in the county recorder's office a number of miscellaneous documents representing claims of various classes to the water of Logan River.

In 1897 the State legislature enacted a law to regulate all subsequent appropriations of water from the public streams and providing for the recording of rights acquired previous to the passage of the act. The recording of such rights was, however, made optional, so that that part of the law has been of little effect.

Below is given an abstract of all records in the county offices pertaining in any way to the water rights of Logan River, or to rights in the canals diverting the water of that stream. By a comparison of this abstract with the table giving the names of canals and their appropriations, it is seen that only three of the irrigation canals have their claims recorded, and that only two of the eleven power plants are mentioned in the record. The certificates of water right recorded are those issued by the water commissioners under the law passed in 1880.[a] The transfers of water right in canals and irrigation districts are those given in connection with the transfers of land.

The law of 1897 provides that all notices of appropriation shall be recorded in a book provided for that special purpose in the county recorder's office, and all records after that date are in accordance with that provision, but the filings prior to that time are recorded with miscellaneous documents.

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[a] Laws of Utah, 1888.

*Record of claims to water from Logan River.*

| Date of filing. | Date of instrument. | Character of instrument. | Name of appropriator. | Purpose of appropriation. | Amount of claim. |
|---|---|---|---|---|---|
| Sept. 1, 1886 | Aug. 30, 1886 | Order confirming referee's report. | Thatcher Mill and Elevator Co. | Power | 120 inches diverted by Logan and Benson Canal. |
| Dec. 20, 1890 | Nov. 29, 1890 | Certificate of primary right. | Providence and Millville irrigation district. | Agricultural and domestic. | 23.46 cubic feet per second. |
| Nov. 13, 1891 | June 5, 1883 | ....do | Hyde Park irrigation district. | ....do | One-half of water diverted by Logan and Hyde Park Canal. |
| Do | Nov. 2, 1891 | Certificate of measurement. | ....do | | 33.60 cubic feet per second. |
| Nov. 28, 1894 | Nov. 1, 1894 | Transfer of right | G. G. Bywater | Irrigation | 200 inches of river. |
| Apr. 13, 1895 | Apr. 13, 1895 | Notice of appropriation. | Crowther & Sons | Power | Indefinite part of Logan River. |
| Nov. 20, 1895 | Nov. 16, 1895 | Transfer of right | Edward Horne | Irrigation | All grantors' right to water in Logan and Richmond Canal. |
| Dec. 21, 1895 | Dec. 21, 1895 | Petition for organization as irrigation district. | Logan and Richmond Canal. | Agricultural and domestic. | 70.28 cubic feet per second. |
| Jan. 27, 1896 | Dec. 7, 1895 | Court decree dividing estate. | Lars Toolson | Irrigation | 9 shares water in Logan and Richmond Canal. |
| Feb. 7, 1896 | Sept. 13, 1895 | Transfer of right | J. P. Christensen | ....do | Water in Logan, Hyde Park and Smithfield Canal for 1 lot. |
| Feb. 10, 1896 | Feb. 10, 1896 | Notice of appropriation. | Hercules Electric Co. | Power | All water in Logan River. |
| Do | ....do | Notice of intended appropriation. | ....do | ....do | All water in Logan River, except right of Logan, Hyde Park and Smithfield Canal. |
| Mar. 7, 1896 | Feb. 5, 1896 | Notice of appropriation. | Hercules Electric Power Co. | ....do | Indefinite part of Logan River. |
| June 15, 1896 | June 15, 1896 | Notice of claim | Crowther & Sons | ....do | All water in river at Maughan Mill. |
| June 30, 1896 | Mar. 9, 1892 | Tranfer of right | Ralph Thornley | Irrigation | 40-acre right in Logan and Richmond irrigation district. |
| Jan. 2, 1897 | Mar. 24, 1896 | Notice of intended canal construction. | Hercules Electric Co. | Power | |
| Mar. 23, 1897 | Dec. 28, 1896 | Court decree dividing estate. | Lars Swensen | Irrigation | 13-acre right in Logan and Richmond irrigation district. |
| June 12, 1897 | Sept. 14, 1895 | Transfer of right | Reuben Hewbold | ....do | 8-acre right in Logan and Richmond irrigation district. |
| June 30, 1899 | May 29, 1899 | ....do | Middlesex Banking Co. | ....do | 2 shares in Logan, Hyde Park and Smithfield Canal. |
| Do | June 24, 1899 | ....do | Robert Drysdale | ....do | 7 shares rights in Logan and Richmond irrigation district. |
| Aug. 29, 1899 | May 1, 1899 | ....do | E. W. Nelson | ....do | Water right in Logan and Benson Canal, amount not stated. |
| Sept. 8, 1899 | Sept. 7, 1899 | ....do | G Beutler | ....do | 2 shares water in Logan and Smithfield Canal. |

*Record of claims to water from Logan River*—Continued.

| Date of filing. | Date of instrument. | Character of instrument. | Name of appropriator. | Purpose of appropriation. | Amount of claim. |
|---|---|---|---|---|---|
| Mar. 5, 1900 | Mar. 5, 1900 | Notice of appropriation. | Thomas Smart, jr | Irrigation | 1 cubic foot per second. |
| Do | do | do | do | Irrigation and power. | 100 cubic feet per second. |
| Mar. 9, 1900 | Feb. 19, 1900 | Transfer of right | Joseph Benson | Irrigation | Water right for 1 lot in Logan and Hyde Park Canal. |
| Mar. 23, 1900 | Mar. 23, 1900 | Notice of appropriation. | Hercules Electric Co. | Power | All unappropriated water. |
| May 31, 1900 | May 31, 1900 | do | do | do | 300 cubic feet per second. |
| Aug. 7, 1900 | June 23, 1900 | Certificate of measurement. | O. C. Blumel | do | 84.67 cubic feet per second. |
| Aug. 16, 1900 | Aug. 16, 1900 | Notice of appropriation. | do | do | 150 cubic feet per second. |
| Aug. 21, 1900 | Aug. 21, 1900 | do | Thomas Smart, jr | Irrigation | 4 cubic feet per second. |

## APPROPRIATORS' CLAIMS.

All the irrigation canals are community property, constructed and managed in every detail by the irrigators. The volume claimed by the canals depends on the area irrigated under them. An individual's share depends on his interest in the canal and is generally reckoned as so many acres of water right; but these shares are held as personal property entirely independent of the land irrigated. The Logan, Hyde Park and Smithfield Canal is the only exception to this rule. A certificate for one share of stock in this company entitles the holder to the use of an irrigating stream during a definite number of hours during the irrigating season. This allowance of water may be used on any lands susceptible of irrigation from the canal. The four largest canals taking water from the river are operated under irrigation district organizations created under the law of 1865. The members of the organization are the coowners of the canal, and the individual landowners are the appropriators of the water. In these organizations a careful record is maintained, showing the number of acres each stockholder is entitled to irrigate during each season. The aggregate of these individual rights represents the claim of the whole canal. A careful determination of the duty of water for each canal would make it possible to estimate the volume to which each is entitled.

In cases where questions of water right have arisen in the courts of the State, it has always been held that the rights acquired are limited by the volume of water used for a beneficial purpose.[a]

In the table which follows are given the results of measurements showing the volumes flowing in the canals at different times during the past two years, together with other information pertaining to the diversion of water from the Logan River. The measurements were made at such times that the results show, in most cases, the maximum and mean volumes used during the season.

[a] Salina Creek Irrigation Company v. Salina Creek Stock Company, 27 Pac., 578; Becker v. Marble Creek Irrigation Company, 49 Pac., 893; Hague v. Nephi Irrigation Company, 52 Pac., 765.

*Canals taking water from Logan River for irrigation.*

| Name of canal. | Bottom width. | Top width. | Mean depth. | Grade. | Capacity. | Discharge of canals. | | Area irrigated. | Date of first use. | Number of owners. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Date. | Volume. | | | |
| | *Feet.* | *Feet.* | *Feet.* | *Per cent.* | *Cu. ft. per sec.* | | *Cu. ft. per sec.* | *Acres.* | *Year.* | |
| Logan, Hyde Park, and Smithfield. | 13.60 | 15.40 | 1.49 | 0.0016 | 59.98 | Aug. 23, 1899<br>July 7, 1900<br>Aug. 18, 1900 | 50.22<br>58.46<br>45.47 | 3,200 | 1862 | 181 |
| Logan and Richmond | 12.25 | 13.25 | 2.91 | .0004 | 117.94 | Aug. 25, 1899<br>July 6, 1900<br>Aug. 11, 1900 | 89.70<br>91.59<br>75.81 | 5,270 | 1865 | 392 |
| Logan Hollow | 3.50 | 6.20 | 1.35 | .0026 | 8.10 | July 6, 1900<br>Aug. 27, 1900 | 2.25 | 90 | 1864 | 31 |
| Logan and Hyde Park | 12.90 | 16.75 | 1.75 | .0029 | 80.54 | Aug. 30, 1899<br>July 23, 1900<br>Aug. 27, 1900 | 45.15<br>47.81<br>32.60 | 2,215 | 1861 | 183 |
| Logan and Benson | 15.80 | 17.22 | 1.80 | .0014 | 40.81 | Aug. 30, 1899<br>July 23, 1900<br>Aug. 27, 1900 | 35.34<br>37.40<br>22.61 | 3,050 | 1864 | 126 |
| Providence | 5.20 | 6.15 | .80 | .0011 | 12.10 | Aug. 24, 1899<br>July 26, 1900 | 7.96<br>8.23 | 400 | 1883 | 45 |
| Logan Nursery | 1.60 | 1.60 | .56 | .0038 | 6.60 | Aug. 25, 1899<br>July 26, 1900 | 3.65<br>4.21 | 100 | ..... | ..... |
| West Field | 7.50 | 8 | .87 | .0033 | 15.62 | Aug. 30, 1899<br>July 23, 1900<br>Aug. 27, 1900 | 9.98<br>10.46<br>8.41 | 1,150 | 1883 | ..... |

## RIGHTS FOR POWER PURPOSES.

Prominent among the claims to water from Logan River are those for power purposes, some of which rank high in order of priority and date back as far as 1860. In reporting on the rights to water in the stream these must receive careful consideration, the more so since most of them receive their water supply from the same channel as do the Logan and Hyde Park and the Logan and Benson canals. The number of power plants thus supplied is at present nine, and claims to water for power purposes and for irrigation aggregating 300 cubic feet per second are involved.

There are two power plants (Group I, in table below) which take their water directly from the river through their own canals and return their tail water directly to the river above all other diversions, so that they do not affect any other rights in the river.

The nine power plants which receive their water supply through channels in common with irrigation canals are located on three levels and may be conveniently regarded as forming three groups. The tail water from each plant is available for use again for power purposes or for irrigation, or both, farther down the river. A list of the power plants appropriating water from Logan River, their respective appropriations as measured by the writer, and certain other data concerning the canals are shown in the following table. The measurements of August 27, 1900, are taken as a basis.

*Appropriations from Logan River for power purposes.*

| Appropriator. | Date of first appropriation. | Wheel capacity. | Discharge measurements. | | Head. |
|---|---|---|---|---|---|
| | | | Date. | Volume. | |
| | | *Cu. ft. per sec.* | | *Cu. ft. per sec.* | *Feet.* |
| GROUP I. | | | | | |
| Hercules Electric Company | 1888 | 111.66 | Aug. 23, 1900 | 103.20 | 33 |
| | | | Aug. 27, 1900 | 106 | |
| O. C. Blumel | 1889 | 61.20 | Jan. 23, 1900 | 64.67 | 18 |
| | | | Aug. 27, 1900 | 0 | |
| GROUP II. | | | | | |
| Deseret Mills | 1866 | 39.90 | Aug. 27, 1900 | 27.85 | 23.5 |
| | | | Oct. 8, 1900 | 26.91 | |
| Central Mills | 1869 | 22.60 | Aug. 27, 1900 | 16.57 | 24 |
| | | | Oct. 8, 1900 | 17.27 | |
| Affleck Machine Shop | 1900 | ..... | Aug. 27, 1900 | 1.68 | 11 |
| | | | Oct. 8, 1900 | 0 | |
| Danielson Manufacturing Company | 1871 | 13.32 | Aug. 27, 1900 | 9.96 | 18 |
| | | | Oct. 8, 1900 | 8.77 | |
| GROUP III. | | | | | |
| Logan Manufacturing Company | 1876 | 8.68 | Aug. 27, 1900 | 8.97 | 12 |
| | | | Oct. 8, 1900 | 7.55 | |
| Thatcher Bros.' Mills | 1880 | 85.32 | Aug. 27, 1900 | 71.16 | 17 |
| | | | Oct. 8, 1900 | 83.96 | |
| Z. C. M. I. | 1880 | 15.12 | Aug. 27, 1900 | 14.79 | 15 |
| | | | Oct. 8, 1900 | 9.06 | |
| GROUP IV. | | | | | |
| Anderson Bros | 1872 | 21.66 | Aug. 27, 1900 | 14.47 | 13 |
| | | | Oct. 8, 1900 | 15.86 | |
| Logan Electric Company | 1872 | 100.00 | Aug. 27, 1900 | 57.21 | 17 |
| | | | Oct. 8, 1900 | 65.09 | |

The power plants of Group II (see fig. 2) make their appropriations through the same channel as does the Logan and Hyde Park Canal, and the five claims, taking the capacity of Logan and Hyde Park Canal as a basis, aggregate 101.23 cubic feet

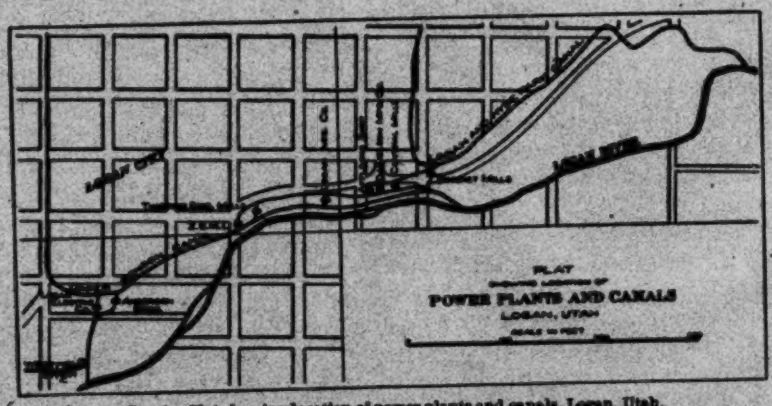


FIG. 2.—Plat showing location of power plants and canals, Logan, Utah.

per second. Deducting the appropriation of the irrigation canal, there remains 56.08 cubic feet per second which is so discharged from the water wheels that it is available for the plants in Group III. The total requirements of the plants in Group III,

however, are 94.94 cubic feet per second, so that an additional supply of 38.86 cubic feet per second is taken from the river through a second channel. All of the water used by the plants of Group III is so discharged that it is available to those of Group IV. To the water requirements of the plants of Group IV, however, must be added the requirements of Logan and Benson Canal, 40.81 cubic feet per second, making the total for that group 112.49 cubic feet per second, so that there is a deficiency in the water supply from Group III of 17.55 cubic feet per second. This is supplied through the same channel as is the 38.86 cubic feet per second for Group III. From the plants of Group IV, deducting that taken by Logan and Benson Canal, there is discharged 71.68 cubic feet per second. This is available only to the Westfield Ditch, which has a capacity of only 15.63 cubic feet per second, so that there is 56.05 cubic feet per second returning to the river not available for irrigation in this locality. Therefore it may be seen that, while the aggregate of mill owners' claims is 428.57 cubic feet per second, the location of their points of discharge with relation to the irrigation canals is such that 372.52 cubic feet per second of this water can be used to supply claims for irrigation, leaving but 56.05 cubic feet per second which is used for power purposes only.

As far as the writer is able to learn, difficulties have arisen between the mill owner and the irrigator regarding their respective rights but twice in the history of the irrigation development of the river. The first of these occurred during a very low-water season about twelve years ago, when the supply was not sufficient for all concerned. At that time the mill owners waived their rights and closed down for a period of two weeks. The second difficulty arose during the summer of 1900. Though not a low-water year, there was a shortage due to the fact that the irrigation canals used unusually large volumes, and the electric company mainly concerned in the matter was in need of a full supply. For the first time all concerned saw the inadequacy of the information at hand for an equitable adjustment of their claims. This realization has caused some of the larger canal companies to desire a settlement of the matter at an early date, and information relating to appropriations is being gathered from all possible sources.

In addition to the present appropriations for power purposes, the Hercules Electric Company has recorded a claim to 300 cubic feet of water per second from the river, which they propose to divert at a point above the head gates of all the canals. A large flume, by means of which the diversion will be made, is now in course of construction. This appropriation can affect only that of the Logan, Hyde Park and Smithfield Canal, as the discharge from the proposed power plant will be above the head gates of all other canals.

## DIVISION OF WATER.

### AMONG CANALS.

The amount of water taken by the Logan River canals has usually been limited only by their capacity. This has been possible on account of the abundant supply of water usually furnished by the river. The matter of having a division of the water has received attention only during seasons of scarcity. When one period of difficulty passed the question was not thought of again until another shortage occurred.

Therefore there has been no system of division employed up to the present time. The water masters of the several canals have charge of the diversion gates and regulate the supply to suit the demand of the irrigators as far as the capacity of the canal will permit.

### AMONG FARMERS.

While no established system of measurement is in use in the division of water among irrigators, there is an effort to make divisions in accordance with the rights in the case. The division is generally made by means of the ordinary rectangular diversion box fitted with a vertical gate. These gates are raised a definite number of inches for an irrigating stream, which is usually supposed to be a certain proportion of the flow of the whole canal. For instance, the water in one of the Logan River canals is divided into thirty irrigating streams. These thirty irrigating streams are rotated among those entitled to water from the canal, each irrigator having the use of a stream for a period of time the length of which depends upon his interest in the canal. Where water is divided on this basis, the variation in the size of the different streams becomes a matter of importance.

During the summer of 1900 the writer made a large number of measurements of the streams apportioned from one of the Logan River canals on the time basis. The measurements were quite carefully made by means of portable weirs. The results show that the streams, which should have been of equal volume, instead of being equal, vary from 0.85 cubic foot to 1.96 cubic feet per second. Where water is distributed on the basis of acreage, and an irrigator is allowed sufficient water for the number of acres represented by his claim, the size of the stream is not a matter of great importance except as it requires a shorter or longer time to irrigate. But even on this basis, difficulties arise, and the division of water from the canals is certainly one of the questions that will need careful consideration in the near future.

The following cases that have been before the courts of Utah indicate the sentiment respecting the practice of dividing water by these two methods:

*Smith* v. *Phillips* (6 Utah, 376).—A decree of the lower court giving defendant one good irrigating stream for sixty hours in every sixteen days "to be measured out and distributed to him, and his use thereof regulated by the water master" was held by the higher court to be void for its uncertainty. The court says: "The statute does not affix to the term 'irrigation stream' a definite and certain meaning, and we have not been referred to anything of which this court can take judicial knowledge that does."

*Holman* v. *Pleasant Grove City* (8 Utah, 78).—A decree of the lower court gave the defendant enough water to irrigate 60 acres. The higher court held that in this case the decree of the lower court was sufficiently accurate, because in times of scarcity water was to be prorated, but where a right is not subject to a pro-rata restriction "the decree should specify the amount of water necessary by an approved mode of measurement."

### CHARACTER OF LITIGATION.

The three cases summarized below are the only ones that have arisen in connection with the irrigation interests of Logan River. While no case is on record actually involving the water rights of the various canals from the river, all three of the cases reviewed have their real foundation in the question of personal water

rights, and there is no doubt that all of them would have been averted had the parties to the suit been supplied with the volume of water to which, in their judgment, they were entitled. So that, while only one of the cases involved water rights directly, both of the others were indirectly concerned in the same question, and the common aim of all those interested as plaintiffs was the determination of their rights to the use of water in relation to the aid they may have given in the construction and maintenance of the canals to divert the water.

ABRAHAM SMITH v. LOGAN, HYDE PARK AND SMITHFIELD CANAL COMPANY.

During the construction of the Logan, Hyde Park and Smithfield Canal in the year 1888 an interest in the water appropriated by the canal was secured by Smithfield through its aid in the work of construction. At that time the canal was not carried far enough north to enable Smithfield to get the full benefit of the water it was entitled to by reason of its interest in the canal. By request, the board of directors of the canal company extended to it the privilege of constructing an extension to the canal and of performing other labor, with the understanding that for the labor thus performed it should be allowed additional shares of stock in the company. This work was done in the year 1889, and a bill rendered to the directors amounting to $555.10. The claim was approved by the directors and the secretary was authorized to issue to Smithfield, in full payment of the claim, a certificate for 118 shares of stock in the company. The officers of the company purchased the lands for the right of way, had made the surveys, and had supervised the work done on this extension, so that when the work was completed they at once took control of that portion of the canal, and it has since been maintained and managed by the corporation and considered a part of their canal system.

At the time the extension was made, and for a number of years afterwards, the capacity of the canal was greater than the demand for water, and the excellent and abundant source of supply made it possible for all who owned stock in the canal to use all the water they needed, and no system of division was used to apportion the water among the irrigators in proportion to their interests in the company. But as the new lands susceptible of supply from this canal began to be reclaimed and the demand for the water supplied by it increased, it became necessary to apportion the water more nearly according to the stock owned by the irrigators. It was at this time that the extra stock that Smithfield had acquired in 1889 became a matter of importance, but an investigation of the matter disclosed the fact to the officials of Smithfield that the certificate for the stock had never been issued by the secretary. They accordingly asked the board of directors of the company to issue them the certificate in accordance with the action of the former board. But ten years had elapsed since the work was done and the information as to the details of the contract was so uncertain that the board refused to issue the certificate, whereupon Smithfield began this suit in the district court to establish the claim.

In the trial of the case it was found very difficult to determine the exact nature of the original contract and of the terms upon which Smithfield was to receive extra shares of stock in the company.

The defense did not deny that the work had been done by the plaintiff city, nor did they disclaim control and supervision of that part of the canal or that it was the property of the corporation. It was fairly well satisfied that Smithfield had used

more water than the amount to which it was entitled by virtue of the undisputed shares of stock owned by it, although the notices of apportionment of water sent to it from year to year by the secretary of the company were based entirely upon this undisputed stock that had been secured at the time the canal was first constructed in 1888. No apportionment notices were ever sent to represent the 113 shares of stock asked for in the suit.

It was also shown that no assessments had been levied on the plaintiff or collected from it on the 113 shares of stock in controversy and that the repairs, enlargements, and improvements on the canal during the years 1889 to 1898 had increased its capacity one-third and necessitated the collection of taxes aggregating the sum of $1.90 on each and every share of the capital stock of the company or an amount equal to $214.70 on the number of shares asked for in the proceedings.

The main contention of the defense was that the action of the board of directors of the company, in 1889, in contracting for the work of construction and extension that had been done by the plaintiff, and in accepting and allowing the bill therefor as a credit on the stock account, was a direct violation of a section in the articles of incorporation of the company, which reads as follows: "The directors of this company shall not have power or authority to borrow money or otherwise obligate the corporation in any sum exceeding $500 without the express authority given by the majority vote of the capital stock of the corporation."

But in case the claim was declared to have been valid in 1889, the defense depended upon the statute of limitations barring it in 1898.

The decision of the court was that the company issue the certificate for the 113 shares of stock claimed in the suit upon the payment by Smithfield of the sum of $214.70, an amount equal to the assessments on a like number of shares for the years 1889 to 1898, or, in case Smithfield so elect, that they receive 85 shares of the capital stock of the company, without the payment of any of the past assessments; and, further, that each party pay half the costs of the suit.

In making his decision the judge mentions the following important features:

(1) When an irrigation corporation surveys for an extension of its canals, and the work of constructing the same is done under the direction and control of the president and other managing officers of the corporation, and the corporation afterwards takes control of such extension and manages and repairs the same and receives the benefit thereof, and afterwards the bill filed by the constructors is allowed by the board of directors of the corporation as a credit of stock to be issued in payment therefor, the court holds that the corporation can not afterwards refuse to issue its stock on the grounds that the contract was beyond the powers of the board. In such case, the corporation having received the benefit of the contract, the issuance of the stock in payment of the labor to the amount of $555.10 can not be prevented by the provision in the articles of incorporation limiting the powers of the board to $500 in the making of contracts.

(2) Under such circumstances, where the corporation by its board of directors allows and approves the bill presented as a credit upon stock account, but fails for a great many years to issue the stock or levy assessments thereon, the statute of limitation does not begin to run in favor of the trustee of the corporation and against the cestui que trust, the person entitled to the stock, until the trustee by clear and unequivocal words or acts disavows or repudiates the trust and the same is brought to the notice of the beneficiary in such a manner that he is called upon to assert his rights.

(3) In such a case, where the value of the canal stock has increased by reason of the yearly assessments, and no assessments have been paid on the stock plaintiff is entitled to have issued, and plaintiff has received a distribution share of the water of the canal each year, it is equitable for the plaintiff to pay an amount equal to the assessments for those years, or receive a diminished amount of stock in proportion to the increased value of the property.

## ALMA HARRIS v. THOMAS TARBETT ET AL., TRUSTEES OF THE LOGAN IRRIGATION DISTRICT.

In order that the causes leading to this litigation and the points at issue in the case may be clearly understood, a brief outline of the development of the irrigation enterprise and the conditions existing at the time the suit was begun will be necessary.

The canal now known as the Logan and Benson was constructed in three sections at three different periods of time. The first section that was built is that portion from the head gates diverting the water from Logan River to the point of crossing the Oregon Short Line Railway, and mentioned in the case under consideration as the Logan Canal. The date of this construction is not definitely known, but by the year 1880 this part of the canal, then about 10 feet wide, had been in operation for some time, and furnished water to irrigate about 1,200 acres of land in the fields west of Logan.

In the year 1880 the farmers of Benson asked the privilege of widening this part of the canal, as the cheapest means of getting water to their lands some distance to the northwest from the terminus of the ditch. Upon the favorable consideration of their request, they widened the canal 2 feet and built an extension which was necessary to conduct the water to their lands. This extension is referred to in the case as the Lower Benson Canal and furnished water for 428 acres of land.

In 1887 the canal was again widened 2 feet, this work also being done by some of the Benson farmers, who added besides another branch to the canal system. This branch was known as the Upper Benson Ditch, and supplied water for about the same number of acres as the Lower Benson Branch.

Up to the year 1887 there had been no definite organization to manage the affairs of the Logan canals, but in the February preceding the building of the Upper Benson Ditch a petition was presented to the county court to organize a certain section of the Logan and Benson fields into an irrigation district, to be known as the Logan irrigation district.

This petition was favorably considered, and as a result the organization was completed and made to include all the lands now irrigated by the Logan and Benson Canal system, and when organized the board of trustees included two representatives from among the Benson farmers who had enlarged the Logan Canal and built the Benson extensions. At that time the canal furnished water to irrigate about 2,500 acres of land, of which 856 acres were in Benson fields.

The construction, maintenance, and management of the canal prior to the organization of the district had been attended to in every detail by those directly interested, and, therefore, as will be noted in the proceedings in court, the Logan farmer had nothing whatever to do with the Benson branches.

At the time the irrigation district was organized there was no determination made as to the lengths of the canals or the limits of the water courses that should be considered the property of the corporation and subject to management and supervision of its officers, nor was a map filed in the county clerk's office, as required by law, to show the limits of the district and the location of the canals and ditches that belonged to it. These omissions and this lack of understanding, in their effect upon the subsequent operation of the canal, are in reality the chief basis of the litigation.

Prior to the incorporation of the district the Benson branches and extensions of the canal had been maintained and controlled entirely by the Benson farmers, and after the organization there was no desire on the part of the Logan farmers that the plan be changed, and they always considered that the officers of the district had nothing whatever to do with the ditches.

Certificates of water right in the corporation were issued to all interested parties in accordance with their credit for aid in construction and enlargement of the Logan Canal, or that portion east of the railroad track, the extensions to Benson not being taken into account in any way whatever in the determination of the rights of the Benson farmers.

With this condition of affairs there was always an uncertainty existing in the minds of the officers of the district as to their jurisdiction over the whole canal system, but during the greater part of the time from 1887 to 1898, though many differences of opinion arose, the majority of the board maintained that the board had no jurisdiction over the Benson part of the canal, and therefore assumed no responsibility whatever for the control or distribution of the water in that part of the district. As a result of this the water master, appointed by the trustees, was authorized to confine his work to the upper section of the canal, and the annual maintenance tax collected from all owners of water right in the district was all expended or applied to the Logan section of the canal.

With the control of their portion of the canal in this unsettled condition, it was not always possible for the Benson farmers to agree among themselves in relation to their individual water rights, and especially was it difficult to satisfactorily adjust the time of their irrigation and the division of the water. Again, from the fact that no system of measurement was used in the distribution of water among the Logan farmers, there was often considerable uncertainty and irregularity in the volume of water that reached the Benson farmers.

After ten years of this indefinite and unsatisfactory arrangement of their irrigation matters, and in view of the continued refusal of the district officers to include the Benson parts of the canal system among the irrigation district canals, about thirty of the farmers of that section, represented by one of their number, Alma Harris, in May, 1898, instituted mandamus proceedings in the district court to compel the board of trustees of the Logan Irrigation District to file a map of the district with the county clerk of Cache County, and to take control of the whole canal system, including the Benson extensions.

In addition to the facts mentioned above, the evidence showed that the officers of the district had on several occasions considered questions pertaining to the plaintiff's part of the district, and at times assumed slight jurisdiction over the canals in controversy; that some of the water masters for that section of the canal had been appointed by the trustees on the recommendation of the farmers of the section, but that they had always been paid for their services by the farmers of the Benson district, and that the part of the canal east of the railroad track had always been maintained by the district as a whole, while the part west of the track had been built and maintained entirely by the Benson farmers, though they had always maintained that the officers of the district should control that part of the canal as well as the older portion.

The decision of the court was in favor of the defendants, the judge in his opinion making prominent the following points:

(1) The canals in controversy were the private property of the Benson farmers before the organization of the district, and should be considered so afterwards, in the absence of evidence to show that the intention was that the organization was to make them the property of the corporation.

(2) In all similar organizations the corporation constructs and maintains only the main line of the canal, leaving the private and lateral ditches entirely in the hands of the individual landholders.

(3) That the plaintiff and those interested with him in the suit constructed the Benson extensions to the canal without any suggestion or aid from the Logan farmers, while the Logan section was constructed by all in common.

(4) It would not only be contrary to the intention of the parties, but contrary to law and justice to hold that, by the organization alone these branches and extensions became the property of the corporation, or that they should be subject to the control and maintenance of the company.

(5) These branches and extensions were not in any way used as a basis for the granting of water rights in the district, and stood in the same position as other laterals leading from the canal.

The writ of mandate was denied by the court and the costs assessed to the plaintiff. The case was at once appealed to the supreme court of the State, where the decision of the district court was reversed, with the costs, and instructions given that the writ of mandate be issued. The text of the supreme court decision is given in part below:

The contention of the appellant is substantially that a board of trustees can not arbitrarily establish limits of a canal system of a district, organized and existing by virtue of the statutes, and deprive stockholders, who are compelled to pay taxes, as provided by law, of the advantage of the district organization. We think this contention is well founded.

The irrigation district in question was organized under the act approved March 13, 1884. (Session Laws 1888, p. 127.) Under the provisions of this act, it is clear that, after an irrigation district was once organized as provided therein, the boundaries thereof determined by such organization, and trustees elected to manage the affairs of the corporation, it became the duty of such trustees to assume jurisdiction of the whole district and control and manage its affairs in accordance with the law under which it was created. There is nothing in the act which authorizes such trustees arbitrarily to assume the management of one portion of the district and reject the other. All the owners of property within the district were, under the law, subject to the payment of an equal rate of taxation for the purpose of creating and maintaining the district organization, and it would be a very harsh and inequitable rule of construction that would deprive them of the right to share in the benefits to be derived by reason of the incorporation. It is also the duty of such trustees, under the law, to file a map with the county clerk of the county in which the district is located, showing the lands comprised in the district, and the location of the canals and ditches as provided in section 10 of the act. When, therefore, in the case at bar the respondents as trustees of the Logan Irrigation District, as shown by the evidence, neglected, and upon demand made refused to take charge of, control, regulate, and maintain the branches of the canal in controversy, and which are within the district, and to distribute and deliver the waters thereof to the appellant and others interested with him, and upon demand made refused to file a map as provided in section 10 of the act of 1884, they became guilty of a willful neglect of duty. As such refusal and neglect affects the rights of the appellant and others who own land in such district and who have borne their portion of the burden to maintain the corporation, as shown by the testimony, the trustees ought to be compelled by mandamus to perform their duty under the law.

This is the first test in the Utah courts of the very important question of the control of irrigation canals by an irrigation district organization, and the first irrigation suit that has dealt with the powers and duties of the officers in such a corporation in so far as they pertain to the control and maintenance of the canals in an irrigation district; and by the decision the following principles have been established:

(1) The bounds of an irrigation district are determined by the bounds of the lands that are taxed for the creation and support of the organization.

(2) The officers of the corporation have jurisdiction over all the main canals and ditches that carry water for the irrigation of any of the lands of the district.

(3) It is not necessary that the canals of a district, in order to bring them under the control of the corporation, shall be a part of the canal system, the construction of which established the limits of the individual incorporator's rights to the use of water.

(4) The board of trustees can not arbitrarily establish the limits of the canals over which they have jurisdiction.

It is suggested by some that when carried to its logical conclusion the result of the decision will involve the control and maintenance by the officers of the district of all the lateral ditches that may be used by a number of irrigators in common, but in the opinion of the writer such a result will not occur because of the increased taxation that would be necessary in such a case.

### ABRAHAM SMITH v. RASMUS NIELSEN ET AL., TRUSTEES OF THE LOGAN AND RICHMOND IRRIGATION DISTRICT.

The Logan and Richmond Canal furnishes a portion of the water for the irrigation of the precincts of Logan, Hyde Park and Smithfield, and the farmers of these three towns are the coowners of the canal and the waters that are diverted by it from Logan River. For a great many years the affairs of the canal have been managed by an irrigation district organization, and in view of the fact that the water had to be conveyed a much greater distance to irrigate the farms of Hyde Park and Smithfield than for those of the Logan fields, it was mutually agreed by the majority of those interested in the matter that the water rights of the Smithfield section should be taxed an additional 20 per cent, and those of Hyde Park an additional 10 per cent, for the purpose of defraying the extra expense of maintaining and operating the canal over this greater distance.

In accordance with this understanding the by-laws of the organization included a clause authorizing the collection of this extra tax from these two towns, and though there was some objection to the provision, by the Smithfield farmers especially, it was levied and collected without material difficulty until the year 1899, when the plaintiff in this case and 47 others of the Smithfield contingent refused to pay the extra tax, and began injunction proceedings in the district court to prevent the selling of their water right, as provided by law in the case of the delinquent taxes of an irrigation district.

The case is still pending in the court, and the outcome is awaited with considerable interest on account of its bearing on the taxes of similar organizations in the State.

The question to be settled in the case is whether or not the taxes of an irrigation district shall be uniform, without regard to the location of the land, and it is expected also to decide whether or not the general custom of taxing water rights double or treble, in cases where they represent claims to water for irrigating gardens and orchards, will be continued. In the outcome of this phase of the question nearly every irrigator of this locality is interested.

## CONCLUSIONS.

Nearly 1,000 irrigators are interested in the water of Logan River, and the canals through which they draw their supply divert water for 13,565 acres of land. Taking the measurements of July and August, 1900, as a basis, the aggregate discharge of the canals was 260.41 cubic feet per second, the minimum discharge of the river during the same months being 299 cubic feet per second. In the discussion of rights for power purposes it has been stated that 56.05 cubic feet per second are needed to satisfy the minimum claims of the power plants, and if the Logan Electric Company and Anderson & Sons should use the volume they claim (85.33 and 21.66 cubic feet per second, respectively), the supply thus used by the power plants which is not available for irrigation purposes would amount to 91.36 cubic feet per second. These figures indicate that the supply in the river was 52.77 cubic feet per second less than the requirements of the appropriators. While this was not a great shortage, it caused considerable discontent among those affected, and raised a question regarding the relative rights of canals, individuals, and power companies which promises to bring these questions up for settlement. Just how this reform will be brought about is a matter that is being discussed by officers of companies, stockholders in canals, and mill owners. All realize how indefinite are their claims. The average farmer opposes an adjudication by the courts, well knowing the uncertainties of such a method of settlement when the facts which should determine the rights are seldom taken into consideration.

The recorded claims, an abstract of which is given above, can not be considered as evidence in the settlement of the rights to use water from the stream. The acreage irrigated can not in justice be the basis, for it is seen from the tables given that the actual appropriation is not proportional to the acreage, and the supreme court of the State has failed to support a decree on such a basis. There are no official measurements of discharges on record. The irrigation laws of the State have provided no means for the collection of such data. With only the evidence that can be gathered from individual sources as a basis for action, there is no wonder that all are united in the belief that the matter should be settled out of court.

The most important question to be determined is not so much the volume of water to which the several canals are at present entitled as the priority of their respective rights. There is probably not a canal whose capacity at the present time is not greater than it was when first constructed. The determination of the dates when additional volumes of water were used will require great care. The records of the canal organization will afford considerable information, but in some cases they are incomplete. It will no doubt be necessary to depend to a greater or less degree on information that can be obtained from old residents. One canal company is already collecting information on this phase of the question. Considering the prevailing sentiment against litigation, the writer doubts very much whether or not the district court will be asked to take up the matter and gather the facts for an adjudication.

It has been proposed that a board of arbitrators collect testimony prior to the settlement of the rights. The board is to determine the location and area of all irrigated land. The canals and the streams shall be shown, together with this land, on a general map. The evidence furnished the board shall state when each tract was

first irrigated, and give such additional information as may affect the rights to use water. All of this information is to be furnished the district court, which is to make an adjudication of the rights in accordance with the facts.

With such a report as a basis it is thought court proceedings could be safely undertaken for the final settlement. While the plan in detail has not been developed, the question of adopting such a procedure is meeting with favorable comment. Judging from opinions expressed by many of those interested, the writer is convinced that there is none who desires anything but a just settlement.

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